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Traffic Information Service (TIS) Planned Product Improvement (P^21) Operational Test Final Report

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16. Abstract

The Traffic Information Service (TIS) Planned Product Improvement (P^2I) final report provides the detailed analysis, results, conclusions, and final recommendations drawn from the Operational Test (OT) test results for the TIS P^2I test effort, which was conducted at the Federal Aviation Administration (FAA) William J. Hughes Technical Center by the Surveillance Branch, ACT-310, from August 14, 2000, through December 22, 2000.

The TIS is a Mode Select (Mode S) Data Link service that delivers automatic traffic advisories to pilots. The primary goal of TIS is to provide an affordable means to assist the pilot in visual acquisition of surrounding air traffic. The service is automated and functions without increasing the workload of air traffic controllers.

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EXECUTIVE SUMMARY

The Traffic Information Service (TIS) is a Mode Select (Mode S) Data Link service that delivers automatic traffic advisories to pilots. The primary goal of TIS is to provide an affordable means to assist the pilot in visual acquisition of surrounding air traffic. The service is automated and functions without increasing the workload of air traffic controllers. The system does not require any changes in the equipage of intruder aircraft.

The TIS Planned Product Improvement (P^2I) is an upgrade to the TIS software that was fielded nationwide in the Mode S Surveillance System during the first quarter of 1998. The five following functional areas were either modified or added to the current TIS baseline software:

1. Reduction in the rate of TIS self-alert generation,
2. Elimination of the Calibration Precision Monitoring Equipment (CPME) targets as candidates for uplink as proximate or threat aircraft,
3. Removal of a pre-existing bug that caused TIS uplinks to be ignored when the TIS client aircraft heading is very near due north,
4. Increase in TIS alert coverage volume from 5 nautical miles (nmi) range and ±1200-foot altitude to 7 nmi range and +3500/-3000-foot altitude (expanded hockey puck),
5. Addition of four new TIS Performance Monitoring Logical Unit (LU) Data Points:

    a. Current Number of TIS clients,
    b. Total Number of TIS Clients (since last sensor reset),
    c. Current Number of TIS Alert Messages (Traffic and Proximity),
    d. Total Number of TIS Alerts (since last sensor reset).

The formal Operational Test (OT) of the TIS P^2I software was conducted at the Federal Aviation Administration (FAA) William J. Hughes Technical Center by the Surveillance Branch, ACT-310, from August 14, 2000, through November 6, 2000. All tests were conducted on a Mode S Terminal sensor in both the 68020 and 68040 Data Processing Subsystem (DPS) hardware configurations, with the exception of the Baseline and Live Flight test cases. These test cases were conducted on the 68040 DPS hardware platform only due to unavailability of the 68020 DPS hardware, and on the belief that neither hardware platform will produce significant variance in the Baseline or Live Flight test results.

Verification of the requirements and the five functional areas modified was conducted using three validation methods: Software Code Inspections, Scenario-Driven Tests, and Live-Flight Tests. Central Processing Unit (CPU) utilization tests were also conducted to determine a recommendation for setting the "TIS Maximum Aircraft Supported" Site Adaptable Parameter (SAP) value.

A Requalification (RQ) OT to verify corrections to outstanding problems discovered during the formal OT was conducted at the Technical Center by ACT-310 from December 18 through 22,

2000. All RQ tests were conducted on the 68040 DPS hardware platform only due to unavailability of the 68020 DPS hardware, and on the belief that neither hardware platform will produce significant variance for the RQ test cases.

Overall results of the OT testing were satisfactory. All of the Software Code Inspection test cases were successfully validated with the exception of one minor error in the code that checks for velocity reasonableness (ground speed check). The Scenario-Driven and Live-Flight testing produced no major problem reports. There was one minor problem (which had been identified in previous TIS testing): a TIS tracking anomaly, which causes the intruder to be displayed on the wrong side of the client during certain maneuvers ("crossover problem"). The CPU Utilization testing indicated that the maximum client SAP should be set to 100 TIS targets for the 68020 DPS hardware configuration and to 150 TIS targets for the 68040 DPS hardware configuration.

After successful completion of the formal OT testing, and an in-depth data analysis and evaluation, the TIS P^2I software has been found to function successfully according to specifications for all measured parameters. The TIS P^2I enhancements had no adverse effects on the general TIS performance and Mode S sensor operations.

Based on these test results, ACT-310 recommends that TIS P^2I software be conditionally approved for national deployment contingent upon the following:

1. All open OT issues listed in OT Issues Matrix (see section 6.1) with the high criticality must be correctly implemented and successfully retested with data analysis and the test results in accordance with specification requirements. See section 7.0 (Addendum) for the results of the OT Issues Matrix Regression testing.

2. The Aeronautical Information Manual (AIM) and all other applicable user documentation must be revised to thoroughly document the tracking limitations ("crossover problem") and potential self-alerts for TIS clients.

3. This version of TIS is only certified for fielding in a terminal sensor configuration.

4. When fielded, the "TIS Maximum Aircraft Supported" SAP be set to the value of 100 targets (or less) for the 68020 DPS hardware platform, and 150 targets (or less) for the 68040 DPS hardware platform.

5. TIS Performance Monitoring LU data points be added to the 68020 baseline and the display problems on the Local Maintenance Terminal (LMT) (going negative at 32,767) be corrected.

6. Successful completion of System Testing and Key-Site by AOS is required.

1. INTRODUCTION.

The Traffic Information Service (TIS) was fielded nationwide as a Preplanned Product Improvement (P^3I) to the Mode S during the first quarter of 1998. Since that time several problems with TIS, including self-alerts that were identified in earlier testing, have been determined to be unacceptable for the certification of TIS avionics. This has resulted in modifications to the TIS ground system to correct and mitigate these known deficiencies and add some other desirable enhancements.

Specifically, these modifications addressed the following five separate functional areas:

a. Reduction in the rate of TIS self-alert generation,
b. Increase in TIS coverage volume from 5 nautical miles (nmi) range and ±1200-foot altitude to 7 nmi range and +3500/-3000-foot altitude,
c. Elimination of the Mode Select (Mode S) Calibration Precision Monitoring Equipment (CPME) targets as candidates for uplink as proximate or threat aircraft,
d. Removal of a pre-existing bug that caused TIS uplinks to be ignored when the TIS client aircraft heading is very near due north,
e. Addition of four new TIS Performance Monitoring Logical Unit (LU) Data Points:

    1. Current number of TIS clients
    2. TIS Clients high-water mark.
    3. Current number of TIS alert messages
    4. TIS alert messages high-water mark.

This document is the Final Report for the Operational Test (OT) of the TIS Planned Product Improvement (P^2I) identified above. A formal OT of the TIS P^2I software was conducted at the Federal Aviation Administration (FAA) William J. Hughes Technical Center by the Surveillance Branch, ACT-310, from August 14, 2000, through November 6, 2000. Sections 2 through 4 document the testing for that effort.

A Requalification OT to verify corrections to outstanding problems discovered during the formal OT of the TIS P^2I software was conducted at the Technical Center by the Surveillance Branch, ACT-310, from December 18 through 22, 2000. An Addendum, section 7, documents the testing for that effort. Sections 5 and 6 provide a summary conclusion and recommendations for both the formal and Requalification test efforts.

1.1 PURPOSE OF REPORT.

The primary purpose of this report is to provide the detailed analysis, results, conclusions, and final recommendations drawn from the OT test results for the TIS P^2I test effort.

1.2 SCOPE OF REPORT.

This report primarily contains an evaluation on the TIS P^2I software enhancements, with the success criteria defined in accordance with attached Test Verification Requirements Traceability Matrix (TVRTM) (see appendix A) for TIS specification requirements.

This test report does not explicitly address reverification of Mode S specifications or performance. Any anomalies in Mode S Performance discovered during the course of the TIS analysis have been reported. A more comprehensive Mode S regression test should be conducted prior to national deployment.

The current Mode S fielded configuration consists of a 68020-based Data Processing Subsystem (DPS) hardware, and there is an on-going effort by AOS to upgrade that hardware platform to a 68040-based DPS configuration. Therefore, the TIS P^2I software enhancements will eventually run on both hardware platforms (68020 and 68040). In order to test and evaluate the TIS P^2I changes for both platforms, tests were conducted on a Mode S Terminal sensor in both the 68020 and 68040 hardware configurations with the following exceptions:

> The Baseline test case (#1), Live Flight test case (#10) and Requalification test cases (#11-15) were conducted on the 68040 hardware platform only due to the unavailability of 68020 hardware, and the belief that neither hardware platform would significantly vary those test results.

Tests performed on both platforms (68020 and 68040) were evaluated and are reported in this report. Additional test events such as the "Addition of four new TIS Performance Monitoring LU Data Points" and the "CPU Utilization Tests," not defined in TVRTM, were conducted and are also reported here. In areas where TIS performed at less than the expected levels, there was a detailed analysis conducted to determine the cause for the deficiency.

The avionics portion of the TIS system, which includes the Mode S Transponders, Airborne Data Link Processor (ADLP) and TIS displays were not evaluated as part of this test and are not reported on here. They were merely used as test tools to collect data (uplink messages) from, and send data (downlink messages) to the Mode S sensor. Previous testing of the ADLP and TIS displays is documented in the Mode S Data Link Applications, Field Demonstration Operational Test and Evaluation Final Report, September 27, 1996, and A Field Evaluation of Data Link Flight Information Services for General Aviation Pilots, February 1997.

2. REFERENCE DOCUMENTS.

a. Appendix XIII of Mode Select Beacon System Sensor Specification, FAA-E- 2716, Traffic Information Service (TIS) Specification, Terminal Sensor Configuration, Revision 4.0, January 19, 2000

b. Mode S Software Modifications to Reduce Traffic Information Service (TIS) Self-Alerts and Increase TIS Coverage Volume (Rev. 1a), February 22, 2000

c. Minimum Operational Performance Standards (MOPS) for Traffic Information Service (TIS) Data Link Communications, April 2, 1997

d. Requirements Document for the Traffic Information System (Rev. 2.3), August 18, 1997

e. Software Detailed Design Document for the Traffic Information System (Rev. 2), June 23, 1997

f. Traffic Information Service (TIS) Developmental / Operational Test and Evaluation (DT&E and OT&E) Final Test Report (DOT/FAA/CT-TN98/10), June 1998

g. New and Improved Traffic Information Service (TIS) Developmental Test and Evaluation (DT&E) System Test Plan, DRAFT, November 12, 1999

h. Federal Aviation Administration (FAA) National Airspace System (NAS) Test and Evaluation Policy and Guidance, Draft - v4f – October 9 1996

i. Traffic Information Service (TIS) Operational Concept (Rev. 1.0), April 1, 1996

3. SYSTEM DESCRIPTION.

3.1 MISSION OVERVIEW.

A primary flight task for all pilots is to maintain awareness of nearby air traffic by maintaining a constant visual scan (whenever meteorological conditions permit). If traffic is sighted, the pilot must first assess the threat posed by the intruder aircraft then, if necessary, maneuver to avoid the other aircraft. This strategy for collision avoidance is termed "see-and-avoid."

The TIS is a data link service that provides information to the cockpit similar to Visual Flight Rules (VFR) radar traffic advisories normally received over voice radio. TIS is intended to improve the safety and efficiency of "see and avoid" flight through an automatic display to inform the pilot of nearby traffic and potential conflict situations. TIS employs an enhanced capability of the terminal Mode S radar system, which contains the surveillance data, as well as the data link required to "uplink" this information to suitably equipped aircraft. Following a one-time data link request for TIS from a client aircraft, the algorithms compute the relative location of all traffic (intruders) in proximity, and provides position, altitude, altitude trend, and course information on up to 8 intruder aircraft within 7 nmi horizontally and +3500/-3000 feet vertically of the client (see figure 3.1-1) on a once per radar scan frequency. TIS will also alert the pilot of all aircraft (in radar contact) within 30 seconds of potential collision, regardless of distance or altitude. The TIS algorithm uses a technique similar to the Traffic Alert and Collision Avoidance System (TCAS) to determine the level of threat posed by each intruder, but provides no resolution advisories.

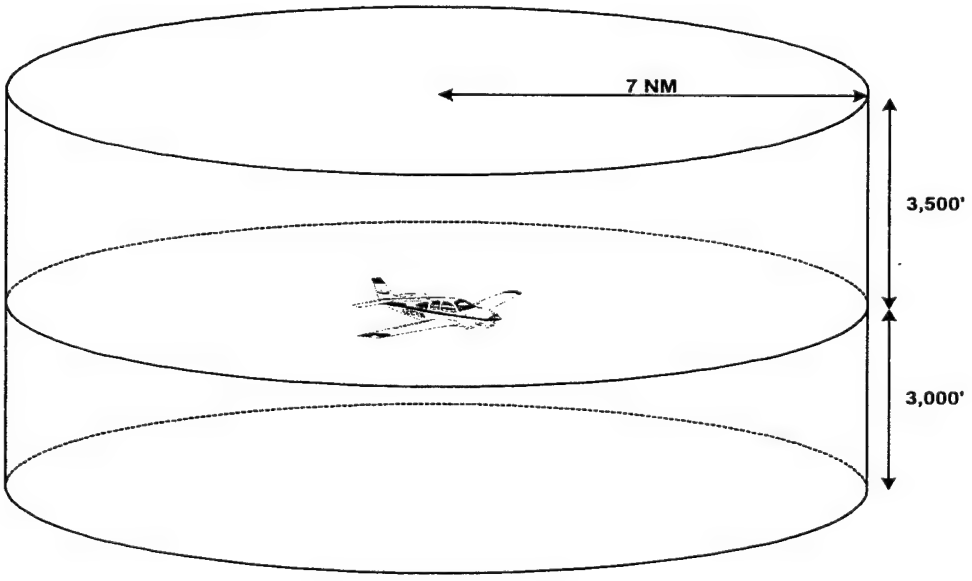


FIGURE 3.1-1. PROPOSED EXPANDED TIS PROXIMITY VOLUME

A diagram of the functional elements of TIS is shown in figure 3.1-2. The TIS algorithms reside in the ground-based Mode S radar beacon sensor. The algorithms access surveillance position reports on all transponder equipped aircraft within the surveillance volume of the Mode S sensor. TIS can be provided to a client aircraft that is operating within the TIS service volume of a TIS-capable Mode S sensor. In order to receive TIS, the client aircraft must be equipped with a data link capable Mode S transponder and an appropriate display device.

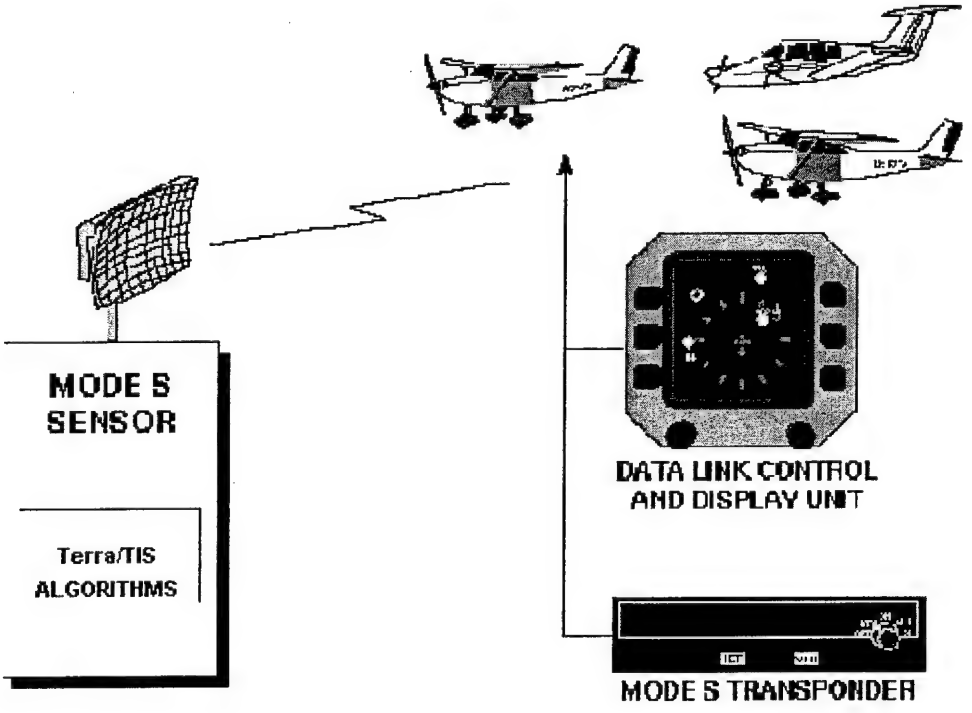


FIGURE 3.1-2. FUNCTIONAL ELEMENTS OF TIS

3.2 TEST SYSTEM CONFIGURATION.

All testing was conducted at the Technical Center short-range radar test facility located in building 270 (Mode S sensor #1). This Mode S sensor is integrated with a collocated Airport Surveillance Radar Model 9 (ASR-9).

3.2.1 Hardware Configuration.

The hardware configuration that was used during the testing is essentially the same as the operational systems located in the field, with exception of the Aircraft Reply and Interference Environmental Simulator (ARIES). The hardware test bed is shown in figure 3.2.1-1 below, and consisted of the following items:

a. Dual channel 68040/68020 hardware platform, Mode S sensor, with single face antenna
b. Collocated ASR-9 Radar

c. Local Maintenance Terminal (LMT)
d. Remote Terminal (RT)
e. Remote Maintenance Monitoring Terminal (MSIMC)
f. Real-Time Aircraft Display System (RTADS)
g. Radar Intelligence Tool (RIT)
h. Aircraft Reply and Interference Environmental Simulator (ARIES)
i. One aircraft equipped with Mode S transponders and prototype ADLP/TIS displays
j. One rack-mount Air Traffic Control Radar Beacon System (ATCRBS) transponder located on second floor of T&A building.

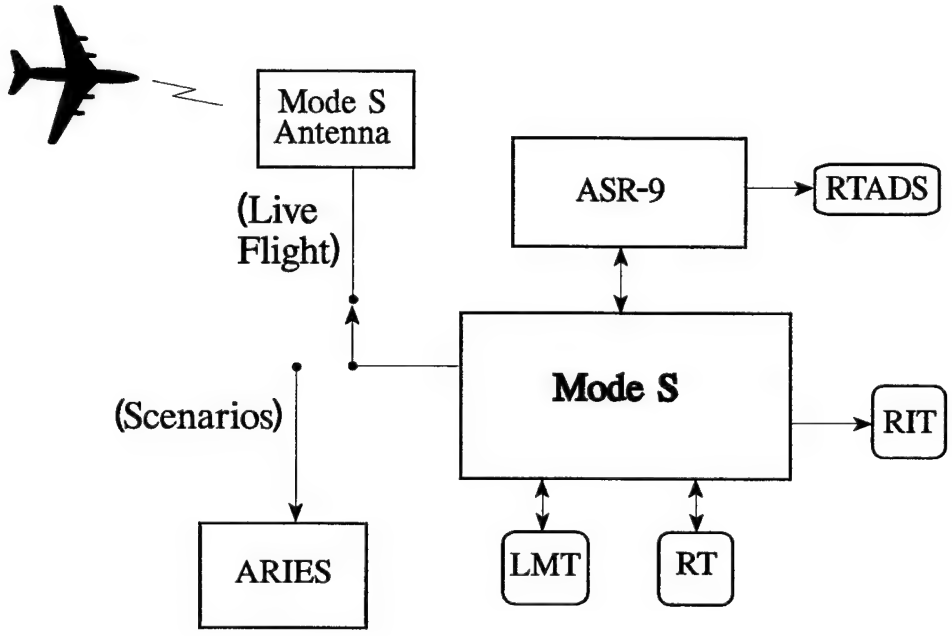


FIGURE 3.2.1-1. MODE S HARDWARE ELEMENTS OF TIS TESTING

3.2.2 Software Configuration.

The TIS software configuration consisted of three System Configuration Management (SCM) controlled software versions (SAR214K, SAE020C and SAE020T). Each of the SCM versions had a companion version built for simulation tests, which was a minor variant designed to run with the ARIES. This ARIES version of the build was required because the ARIES does not fully support the data link protocol used by TIS. A one-line change to use pilot-initiated downlinks instead of broadcast downlink messages to request TIS service was the only difference between the two builds. Below is a summary of the builds used during this test and their contents (table 3.2.2-1).

TABLE 3.2.2-1. SUMMARY OF SOFTWARE BUILDS AND CONTENTS

SW Version Name	Description	TIS Content
SAR214K and SAR214K-ARIES	Terminal Sensor 68020 Releases for Live Antenna and ARIES with TIS P^2I's built on currently fielded baseline (SAR214J)	Currently Fielded TIS plus: + Self-Alert Reduction fix, + CPME non-intruder fix, + North heading fix, + Expanded hockey puck (7nmi, +3500',-3000').
SAE020C and SAE020C-ARIES	Combined En Route/Terminal Sensor 68040 Releases for Live Antenna and ARIES planned for National Baseline. These builds contain currently fielded TIS functionality (as in SAR214J) with the addition of expanded hockey puck.	Currently Fielded TIS plus: Expanded hockey puck (7nmi, +3500',-3000')
SAE020T and SAE020T-ARIES	Combined En Route/Terminal Sensor 68040 Releases for Live Antenna and ARIES with TIS P^2I's built on planned National Baseline (SAE020C).	Currently Fielded TIS plus: + Self-Alert Reduction fix, + CPME non-intruder fix, + North heading fix, + Expanded hockey puck, + New TIS LU data points.

Each SCM Release came complete with a Mode S System Image (which runs on the sensor) and associated terminal software releases for the Local, Remote, and Maintenance terminals. SAE020C-ARIES running with the test target simulator (ARIES) was utilized to collect data during the Baseline test phase. SAE020T-ARIES contained the TIS P^2I software modifications built on the SAE020C baseline. Baseline data were compared to data collected running SAE020T-ARIES against the same identical scenarios. Both SAE builds ran on the 68040 DPS hardware configuration.

The SAR214K pair of releases contained the TIS P^2I software modifications built on the currently fielded SAR214J Baseline. This pair of builds ran on the 68020 DPS hardware configuration. Baseline data were compared to data collected running SAR214K-ARIES against the same identical scenarios.

The release version SAE020T was used for all live flight testing, and is the version that will initially be fielded once testing has been successfully completed

The TIS avionics, which consisted of a data link-capable Mode S transponder, ADLP, Cockpit Display of Traffic Information (CDTI), and TIS display software, used during the live flight tests contained the latest software versions that contained TIS functionality and data recording, available at test time. The TIS avionics software was not being tested here but merely used a test tool to record uplink and downlink data to verify the ground-based TIS software. Additional avionics testing will be required at a later date.

3.3 INTERFACES.

Since the TIS software resides entirely within the Mode S sensor, all software interfaces are to Mode S functions and/or subsystems. The overall architecture of the TIS software is shown in figure 3.3-1. There are two TIS processing tasks: the tracker, and the alert generator. The tracker task receives inputs from the sensor surveillance functions and maintains a local TIS track file that is shared between the TIS tracker task and alert generation task. TIS tracks are updated at the time that surveillance inputs appear. Any TIS messages generated in the alert generation task are fed to the sensor data link functions. An input from the sensor data link functions provides the source of TIS downlink request messages which enable or disable TIS service to a particular aircraft. TIS also attaches to the sensor software performance monitor and data extraction functions (not shown in the figure).

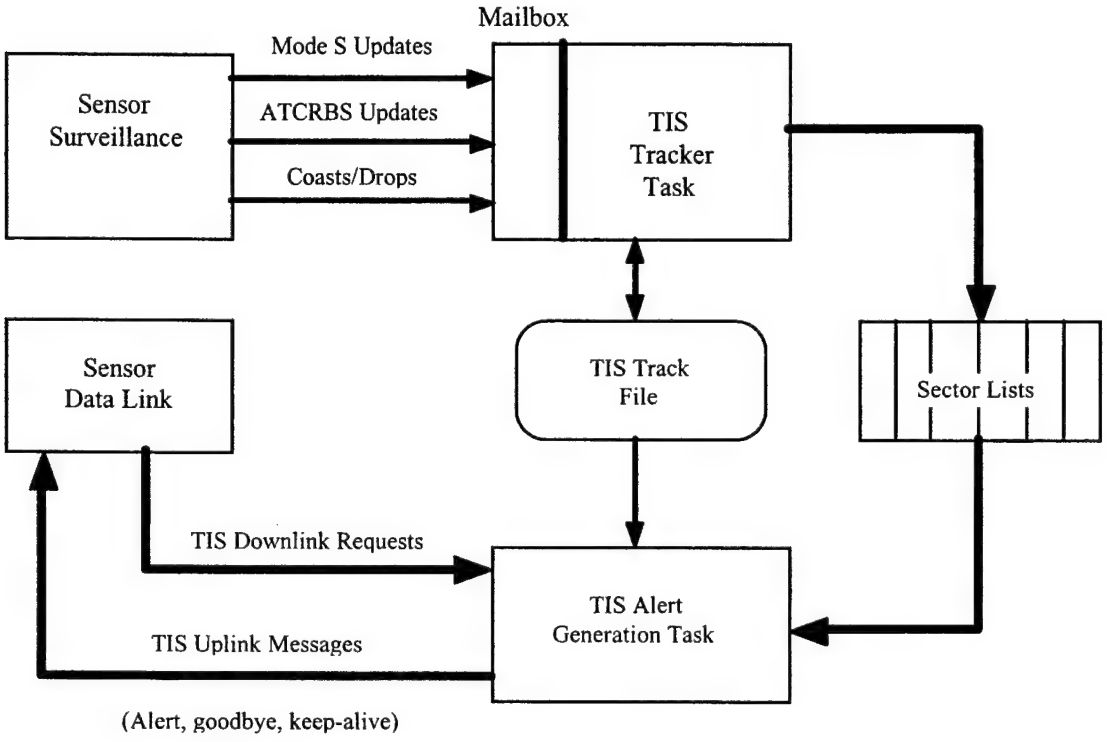


FIGURE 3.3-1. ARCHITECTURE OF THE TIS SENSOR SOFTWARE

4. TEST AND EVALUATION DESCRIPTION.

The introduction of 5 Planned Product Improvements into the fielded TIS baseline added 2 new requirements and modified 38 of the 380 existing TIS requirements. An additional 40 high-level existing requirements were also verified to ensure introduction of the new or modified requirements, did not degrade TIS performance, nor have negative side effects.

Verification of these 80 TIS requirements were logically grouped by function, and split into 3 major test phases: (1) Baseline Performance test phase, (2) TIS P^2I test phase, and (3) Regression test phase identified below:

a. The Baseline Performance test phase established the current level of TIS performance (primarily self-alert generation) for the currently fielded TIS Release. Data were collected during the Baseline phase strictly for comparison purposes in evaluating how well the TIS P^2I performed.

b. The TIS P^2I test phase was used to verify the new fixes and associated requirements being incorporated into this release.

c. The Regression test phase was used to verify the new fixes did not degrade TIS performance nor have negative side effects.

Each test phase used one or a combination of three test methods: (1) Software Code Inspection, (2) Test Scenarios, and (3) Live Flight Test described below:

a. Software Code Inspections (CI) consisted of an examination of source code listings with comparisons to algorithms defined in the requirements. No recording of quantitative data except source code module name and line number were kept. This method was only used to verify requirements that would otherwise be extremely difficult, time-consuming, or impossible to test at a system-level.

b. The Test Scenarios method used simulated targets, generated by the ARIES, that exercised the system while data was recorded for later analysis. This method provided a comprehensive, cost effective, set of repeatable test cases, that would otherwise be extremely difficult, expensive, and/or time-consuming to accomplish with live targets.

c. The Live Flight Test method used test aircraft to verify requirements that related to the aircraft transponder operation. Uplink and downlink transmission messages were recorded during the live flights for later analysis. It consisted of a limited set of test cases that were the final system check to verify that the TIS was functioning correctly in a full-up operational environment.

4.1 BASELINE PERFORMANCE TEST PHASE.

The Baseline test phase established for test purposes, the current Baseline level of TIS Performance for the currently fielded TIS Release. Data collected during this test phase was

used for later comparison with the TIS P^2I Test Phase. It consisted of one test case described below.

4.1.1 Test Case #1: Current TIS Performance.

This test case was conducted using simulated test targets with the current Baseline TIS software running on the 68040 DPS hardware platform only. No requirements were verified.

4.1.1.1 Test Objective.

The objective of this test was to establish the current TIS Performance Baseline under the nominal Mode S system case in a representative Mode S terminal configuration. This test established the current Baseline level of degradation for the fielded Mode S/TIS system (68040 DPS hardware platform) without the TIS P^2I enhancement present and operational.

4.1.1.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting Data Extractions (DE) as configured in table 4.1.1.2-1.

TABLE 4.1.1.2-1. TEST CASE #1 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
Fielded Release (SAE020C-ARIES) w/Terra Mode Enabled	TISPERF1 TISPERF2	TISPERF1.DE TISPERF2.DE	2, 5,6, 9-12, 78,79, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

4.1.1.3 Data Collection and Analysis Method.

The RBAT-TIS Analysis tool was used to obtain a summary of TIS alerts, and also the number of relative rate of self-alerts.

4.1.1.4 Results and Discussion.

Result 1:

The following results were obtained from analysis output file TISPERF1.001, which was generated from the TIS Analysis tool for the data of file TISPERF1.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	*faa006*	*36*	*100.0*	*38*	*5.3*	*90*	*100.0*	*90*	*0.0*
2	faa005	36	100.0	36	0.0	91	100.0	91	0.0
3	*faa004*	*2*	*100.0*	*10*	*80.0*	*42*	*100.0*	*43*	*2.3*
5	*faa100*	*0*		*19*	*100.0*	*6*	*100.0*	*6*	*0.0*
6	*faa200*	*0*		*29*	*100.0*	*7*	*100.0*	*7*	*0.0*
7	faa003	0		0		41	100.0	41	0.0
8	faa010	49	100.0	49	0.0	27	100.0	27	0.0
9	faa030	0		0		13	100.0	13	0.0
10	faa020	0		0		14	100.0	14	0.0
11	*faa002*	*0*		*3*	*100.0*	*0*		*0*	
12	faa001	0		0		0		0	
13	*faa050*	*13*	*100.0*	*15*	*13.3*	*230*	*100.0*	*233*	*1.3*

14	faa040	13	100.0	13	0.0	225	100.0	225	0.0
15	faa007	49	100.0	49	0.0	27	100.0	27	0.0
16	faa020	0		0		16	100.0	16	0.0
17	faa030	0		0		17	100.0	17	0.0
18	faa070	0		0		0		0	
19	*faa001*	*0*		*2*	*100.0*	*0*		*0*	
20	faa001	0		0		0		0	
TOTAL		198	100.0	*263*	*24.7*	846	100.0	850	0.5

Number of antenna updates = 657
Number uncorrelated TIS advisory messages = 69
Number uncorrelated advisory messages = 0

Discussion 1:
As shown in the above result, there were 263 traffic advisory alerts but 24.7 percent of them were false traffic alerts (self-alerts). These false alerts were found on targets: faa001, faa002, faa004, faa006, faa050, faa100, and faa200.

Result 2:
The following results were obtained from analysis output file TISPERF2.001, which was generated from the TIS Analysis tool for the data of file TISPERF2.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa007	26	100.0	28	7.1	189	100.0	189	0.0
2	*faa108*	*25*	*100.0*	*26*	*3.8*	*191*	*100.0*	*191*	*0.0*
3	faa107	27	100.0	27	0.0	189	100.0	189	0.0
4	*faa003*	*10*	*100.0*	*15*	*33.3*	*47*	*100.0*	*48*	*2.1*
5	faa103	11	100.0	11	0.0	46	100.0	46	0.0
6	*faa002*	*9*	*100.0*	*10*	*10.0*	*48*	*100.0*	*48*	*0.0*
7	*faa102*	*9*	*100.0*	*10*	*10.0*	*48*	*100.0*	*48*	*0.0*
8	faa302	5	100.0	5	0.0	4	100.0	4	0.0
9	faa001	9	100.0	9	0.0	48	100.0	48	0.0
10	*faa201*	*10*	*90.0*	*10*	*10.0*	*147*	*100.0*	*147*	*0.0*
11	faa301	0		0		157	100.0	165	4.8
12	faa101	9	100.0	9	0.0	48	100.0	48	0.0
13	faa006	9	100.0	9	0.0	31	100.0	31	0.0
14	faa005	8	100.0	8	0.0	32	100.0	32	0.0
15	faa004	7	100.0	7	0.0	33	100.0	33	0.0
16	faa104	8	100.0	8	0.0	32	100.0	32	0.0
17	faa105	8	100.0	8	0.0	32	100.0	32	0.0
18	faa106	9	100.0	9	0.0	31	100.0	31	0.0
19	faa203	0		0		27	100.0	27	0.0
20	faa303	0		0		27	100.0	27	0.0
21	faa009	25	100.0	25	0.0	190	100.0	190	0.0
22	faa008	24	100.0	24	0.0	191	100.0	191	0.0
23	faa109	27	100.0	27	0.0	188	100.0	188	0.0
24	faa202	5	100.0	5	0.0	4	100.0	4	0.0
TOTAL		280	99.6	*290*	*3.8*	1980	100.0	1989	0.5

Number of antenna updates = 224
Number uncorrelated TIS advisory messages = 20
Number uncorrelated advisory messages = 1

Discussion 2:
As shown in the above result, there were 290 traffic advisory alerts but 3.8 percent of them were false traffic alerts (false-alerts). These false alerts were found on targets: faa007, faa108, faa003, faa002, faa102, and faa201.

4.1.1.5 Conclusions.

False alerts were found (24.7 percent error with TISPERF1.SEN and 3.8 percent error with TISPERF2.SEN) when running the subject scenario files on ARIES under the current fielded Mode S/TIS system image version (SAE020C) without the TIS P^2I enhancement. The false alert rates for these scenarios were comparable to results from TIS flight tests conducted in November 1999. Based on the above result, these scenario files (TISPERF1.SEN and TISPERF2.SEN) were adequate for comparisons on both hardware platforms (68020 DPS and 68040 DPS) and builds (SAR214K and SAE020T) with the TIS P^2I enhancements to determine the degree of success attained. It was determined that rerunning the Baseline with the 68020 DPS hardware platform was unnecessary because of identical functionality of the two platforms.

4.2 TIS PLANNED PRODUCT IMPROVEMENT TEST PHASE.

The TIS P^2I test phase was used to verify the new TIS Planned Product Improvements and associated requirements being incorporated into this release. Thirty-eight modified and two new requirements were verified using three test methodologies (code inspect, simulated targets, and live flight) within four test cases during this test phase. All test cases of this phase were conducted with the improved TIS software on both 68020 and 68040 DPS hardware platforms.

4.2.1 Test Case #2: Low-Level TIS Requirements.

This test case was conducted using code inspection techniques. Twenty-three of the 40 requirements in this phase were verified using software code inspection.

4.2.1.1 Test Objective.

The objective of this test method was to verify that low-level TIS tracking and alert processing algorithms function correctly, as defined in the TIS specification. The following TVRTM requirements were verified: 15.1, 45.1, 45.2, 51.1, 129.1, 211.2, 211.3 ,224.1-7, 225.1-9 (see appendix A for detailed requirements).

4.2.1.2 Test Description.

The code inspections were conducted in a methodical and systematic manner using procedures that identified specific software code and the requirement(s) that it satisfied. Software code listings for both the 68020 and 68040 build images (SAE020T and SAR214K) were inspected. The code inspections were conducted at the Technical Center, Atlantic City International Airport, by ACT-310 personnel. Verification started the week of September 11, 2000, and continued until completion on October 20, 2000. This effort was conducted in parallel with the other test cases and did not require any test prerequisites.

4.2.1.3 Data Collection and Analysis Method.

No formal data collection was required for the code inspection. Analysis consisted of visually comparing the selected software source code sequences to the algorithms in the TIS specification.

4.2.1.4 Results and Discussion.

The software module name and line number where each requirement is verified is identified below:

Req 15.1: Verify that reference_track and reference_count have been added to the TIS Track File.
Module: SP_tisnl.h
Line#: 359
Discussion: The fields self_reference and self_ref_count are defined in the TISSEPTYPE structure and are part of the TIS Track File that is used in the TIS_Processing Task.

Req 45.1-2: Altitude of sensor used by TIS is designated by SAP.
Module: tistrk_exec.c
Line#: 390, 534
Discussion: Algorithms and calculations using sensor altitude use the value of site_altitude in the SAP CONFIG_TABLE.

Req 51.1: TIS Track File elements reference_track and reference_count shall be initialized to zero.
Module: tisproc_exec.c
Line#: 385
Discussion: TIS Track File elements self_reference and self_ref_count are initialized to zero during initial processing of a new TIS requesting track.

Req 129.1: The horizontal track update to a TIS track whose horizontal track state is FIRST shall perform the following: set track "reference-track number" and "reference-track" coast count to zero.
Module: tisproc_exec.c - module is in TIS_Procesing_Task
Line#: 385
Discussion: The initialization of these fields only takes place for a TIS Client for avoidance of a self-alert. There is no reference to R/N 129.1 in the TIS Tracking code, but only in the TIS Processing code. The part of the TIS Track File that contains these fields is only used in the TIS Processing Task.

Req 211.2: The azimuth threshold shall be determined using the function az_thresh() as defined in the requirements document.
Module: processing.c
Line#: 722
Discussion: The code as implemented in az_thresh() logically matches the pseudo-code in the requirement document.

Req 211.3 and 224.1-3: The match of the ATCRBS against ModeS track shall be determined using the function TERRA_match() as defined in the requirements document. If TERRA velocity checks are to be performed and either of the Cartesian absolute velocities exceeds the threshold, then a comparison of the tracks' ground-speed shall be performed.

Module: processing.c
Line#: 785, 845
Discussion: The actual function name is self_match(). If either of the Cartesian absolute velocities exceed the threshold, then a comparison of the tracks' ground-speed shall be performed. The code is implemented so that the ground-speed check is done if dx <= vthreshold ***and*** dy is > vthreshold, not if either exceeds the threshold. In other words, if dx exceeds the threshold, the test is not done. The rest of the code matches logically in accordance with the requirement document.

Req 224.4-5: If track heading comparison is performed and the absolute difference is greater than 30°, then TERRA match shall be declared a failure. Otherwise, TERRA match shall be declared a match with the input TIS track.

Module: processing.c
Line#: 866
Discussion: The code matches the requirement.

Req 224.6: A flag "duplicate" shall be used to indicate whether a TERRA match for the Mode S track has been found yet.

Module: processing.c
Line#: 164
Discussion: Duplicate is declared on line 164 and used in tis_handler() and tisalert_check().

Req 224.7: The variable "atcrbs_ref" shall be used to store the input Mode S track's ATCRBS "reference track".

Module: processing.c
Line#: 243
Discussion: There is no variable "atcrbs_ref" used in the code, but the code is logically consistent with the requirement. The code uses the self_reference field of the track file instead of declaring and using the atcrbs_ref variable.

Req 225.1-5: The processing for suppression of TERRA duplicate tracks shall be performed as shown in the pseudo-code in the requirements.

Module: processing.c
Line#: 241
Discussion The code as implemented meets the requirements for 225.1 – 225.5.

Req 225.6-9: If the sensor is operating in TERRA mode and no TERRA match has been found, then further checking shall be done to each ATCRBS track input to alert generation as shown in the pseudo-code in the requirements.

Module: processing.c
Line#: 422
Discussion The code as implemented meets the requirements for 225.6 – 225.9.

4.2.1.5 Conclusions.

Three of the code inspect requirements were found to be noncompliant. These requirements are identified below:

Req 129.1 - There is no reference to R/N 129.1 in the TIS Tracking code, only in the TIS Processing code. The part of the TIS Track File that contains these fields is only used in the TIS Processing Task. This requirement may need to be rewritten.

Req 211.3 - The ground speed portion of the algorithm has not been implemented correctly.

Req 224.7 - There is no variable "atcrbs_ref" used in the code as called for in the requirement, but the code meets the requirement intent. Recommend deletion of the variable "atcrbs_ref" in the requirement.

4.2.2 Test Case #3: Terra Processing Algorithm and TIS Coverage Volume.

4.2.2.1 Test Objective.

The objectives of this test were to verify for both hardware platforms and builds, that the additional Terra checking functions in TIS P^2I software enhancements were performed under Terra mode to prevent self-alerts during the alert determination process. This test case also to verify that the Terra/TIS coverage volume "hockey puck" was increased to 7 nmi range and +3500/-3000-foot altitude.

4.2.2.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.2.2.2-1.

TABLE 4.2.2.2-1. TEST CASE #3 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE File(s)	DE Categories *
TIS P2I Test Releases (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	TERP2I	TERP2I.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

4.2.2.3 Data Collection and Analysis Method.

RBAT TIS Analysis and Surveillance Print tools were used to obtain a summary/listing of TIS alerts and surveillance ATCRBS/Mode S reports.

4.2.2.4 Results and Discussion for 68020 Platform.

Result 1:

The following results were obtained from analysis output file TERP2I.001, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa001	0		28	100.0	0		0	
2	faa002	1	0.0	26	100.0	0		0	
3	faa003	0		123	100.0	0		0	
4	*faa004*	*0*		*0*		*0*		*0*	
5	faa005	6	100.0	6	0.0	85	100.0	85	0.0
6	faa006	6	100.0	6	0.0	168	100.0	168	0.0
7	faa007	0		0		84	100.0	84	0.0
TOTAL		13	92.3	189	93.7	337	100.0	337	0.0

Number of antenna updates = 125
Number uncorrelated TIS advisory messages = 177
Number uncorrelated advisory messages = 1

Discussion 1:

As shown in the above result, the TIS client (FAA004) with unclear altitude received no TIS alert. Therefore, when either track lacks a clear altitude, the altitude difference between the tracks (Mode S and ATCRBS) was assumed to be 0. The result also shows that ATCRBS track (0004) did not generate any alert against the Mode S track (FAA004). It means the alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track (in order to prevent TIS self-alert).

Result 2:

Target FAA001:

The following results were obtained from analysis output file TERP2I.002, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	ATyp	Bear	Range	RelAlt
17:50:49.852	23.8	135.1	5000			faa001	258	N	T						
17:50:54.461	24.0	135.0	5000			faa001	258	N	T						
17:50:59.070	*24.2*	*135.0*	*5000*			*faa001*	*258*	*N*	*T*						
17:51:03.688	24.4	135.0	5000			faa001	258	N	T						
17:51:08.297	24.6	135.0	5000			faa001	258	N	T						
17:51:12.914	24.8	135.0	5000		135.0	faa001	258	N	T	0001	265	TIS	9.0	0.3	50
17:51:17.523	25.0	135.0	5000		141.0	faa001	258	N	T	0001	265	TIS	9.0	0.3	50

The following results were obtained from analysis output file TERP2I.003, which was generated from the Surveillance Print tool for the data of file TERP2I.DE:

Time-Of-Day	Cls	A S	Mo de	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
17:50:49.867	RPT	A		24.02	135.00		F			0001	5000	1.8	boresight_bit=0
17:50:49.852	RPT	S		23.83	135.07		F		faa001	0001	5000	1.8	#ac=0 #rc=1 fs=0

```
17:50:54.469 RPT A     24.21 135.02        F              0001    5000   1.8 boresight_bit=0
17:50:54.461 RPT S     24.03 135.04        F       faa001 0001    5000   1.8 #ac=0 #rc=1 fs=0
17:50:59.078 RPT A     24.41 135.04        F              0001    5000   1.7 boresight_bit=0
17:50:59.070 RPT S     24.21 135.04        F       faa001 0001    5000   1.8 #ac=0 #rc=1 fs=0
17:51:03.703 RPT A     24.60 135.02        F              0001    5000   1.7 boresight_bit=0
17:51:03.688 RPT S     24.41 135.00        F       faa001 0001    5000   1.7 #ac=0 #rc=1 fs=0
17:51:08.305 RPT A     24.80 135.02        F              0001    5000   1.7 boresight_bit=0
17:51:08.297 RPT S     24.60 135.02        F       faa001 0001    5000   1.7 #ac=0 #rc=2 fs=0
17:51:12.930 RPT A     24.99 135.02        F              0001    5000   1.7 boresight_bit=0
17:51:12.914 RPT S     24.80 135.02        F       faa001 0001    5000   1.7 #ac=0 #rc=1 fs=0
17:51:17.531 RPT A     25.18 135.04        F              0001    5000   1.7 boresight_bit=0
17:51:17.523 RPT S     24.98 135.02        F       faa001 0001    5000   1.7 #ac=0 #rc=2 fs=0
```

Discussion 2 (for target FAA001):
The Terra match on TIS client FAA001 failed when the range difference between the two tracks (Mode S and ATCRBS) exceeded the range threshold (.18 nmi) starting at 17:50:59.070. TIS alerts were sent to the client FAA001 after three coasts.

Target FAA002:

The following results were obtained from analysis output files TERP2I.004, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

```
 Time-Of-Day Range Azmth   Alt  Head TisHd Mds-Id  SFN T M     Id  SFN ATyp  Bear Range RelAlt

17:50:27.367  12.5 180.0 19500             faa002  259 N T
17:50:31.977  12.3 180.0 19500             faa002  259 N T
17:50:36.594  12.1 180.0 19500             faa002  259 N T
17:50:41.203  12.0 180.0 19500             faa002  259 N T
17:50:45.813  11.8 180.0 19500             faa002  259 N T
17:50:50.430  11.6 180.0 19500         3.0 faa002  259 N T   0002  266  TIS  87.0   0.3     50
17:50:55.039  11.4 180.0 19500         3.0 faa002  259 N T   0002  266  TIS  93.0   0.3     50
```

The following results were obtained from analysis output file TERP2I.005, which was generated from the Surveillance Print tool for the data of file TERP2I.DE:

```
                A Mo                        F      Mode S  3/A    Alti  Elev
 Time-Of-Day Cls S de  Range Azimth    OBA B Trck      Id Code    tude Angle

17:50:27.367 RPT A     12.51 179.12        F              0002   19500  14.7 boresight_bit=0
17:50:27.367 RPT S     12.51 180.00        F       faa002 0002   19500  14.7 #ac=0 #rc=1 fs=0
17:50:31.977 RPT A     12.32 179.32        F              0002   19500  14.9 boresight_bit=0
17:50:31.977 RPT S     12.32 180.02        F       faa002 0002   19500  14.9 #ac=0 #rc=1 fs=0
17:50:36.594 RPT A     12.13 179.10        F              0002   19500  15.2 boresight_bit=0
17:50:36.594 RPT S     12.13 180.02        F       faa002 0002   19500  15.2 #ac=0 #rc=1 fs=0
17:50:41.203 RPT A     11.95 179.10        F              0002   19500  15.4 boresight_bit=0
17:50:41.203 RPT S     11.95 180.00        F       faa002 0002   19500  15.4 #ac=0 #rc=1 fs=0
17:50:45.805 RPT A     11.76 179.06        F              0002   19500  15.7 boresight_bit=0
17:50:45.813 RPT S     11.77 180.02        F       faa002 0002   19500  15.7 #ac=0 #rc=1 fs=0
17:50:50.430 RPT A     11.57 179.03        F              0002   19500  16.0 boresight_bit=0
17:50:50.430 RPT S     11.58 180.04        F       faa002 0002   19500  15.9 #ac=0 #rc=1 fs=0
17:50:55.031 RPT A     11.39 178.95        F              0002   19500  16.2 boresight_bit=0
17:50:55.039 RPT S     11.39 180.00        F       faa002 0002   19500  16.2 #ac=0 #rc=2 fs=0
```

Discussion 2 (for target FAA002):
The Terra match on TIS client FAA002 failed when the azimuth difference between the two tracks (Mode S and ATCRBS) exceeded the azimuth threshold (.88°) starting at 17:50:36.594. TIS alerts were sent to the client FAA002 after three coasts.

Target FAA003:

The following results were obtained from analysis output files TERP2I.006, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	ATyp	Bear	Range	RelAlt
17:43:41.594	*30.7*	*199.1*	*5000*			*faa003*	*260*	*N*	*T*						
17:43:46.203	30.5	199.2	5000			faa003	260	N	T						
17:43:50.836	30.3	200.2	5000		315.0	faa003	260	N	T	0003	267	TIS	159.0	0.8	250
17:43:55.430	30.1	199.4	5000		39.0	faa003	260	N	T	0003	267	TIS	87.0	0.1	350

The following results were obtained from the analysis output file TERP2I.007, which was generated from Surveillance Print tool for the data of file TERP2I.DE:

Time-Of-Day	Cls	A S	Mo de	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
17:43:23.141	RPT	A		31.41	198.50		F			0003	5000	1.3	boresight_bit=0
17:43:23.133	RPT	S		31.41	198.61		F		faa003	0000	0	-0.2	#ac=4 #rc=0 fs=0
17:43:27.766	RPT	A		31.22	198.74		F			0003	5100	1.3	boresight_bit=0
17:43:27.750	RPT	S		31.22	198.74		F		faa003	0003	5000	1.3	#ac=6 #rc=2 fs=0
17:43:32.359	RPT	S		31.05	198.85		F		faa003	0003	5000	1.3	#ac=2 #rc=2 fs=0
17:43:32.383	RPT	A		31.05	199.25		F			0003	5100	1.3	boresight_bit=0
17:43:32.375	RPT	A		31.05	198.83		F			0003	0	0.0	boresight_bit=0
17:43:36.984	RPT	A		30.86	198.94		F			0003	5100	1.3	boresight_bit=0
17:43:36.969	RPT	S		30.86	198.96		F		faa003	0003	5000	1.3	#ac=0 #rc=2 fs=0
17:43:41.609	RPT	A		30.69	199.09		F			0003	5200	1.4	boresight_bit=0
17:43:41.594	RPT	S		30.68	199.07		F		faa003	0003	5000	1.3	#ac=0 #rc=1 fs=0
17:43:46.211	RPT	A		30.50	199.18		F			0003	5200	1.4	boresight_bit=0
17:43:46.203	RPT	S		30.50	199.20		F		faa003	0003	5000	1.3	#ac=0 #rc=2 fs=0
17:43:50.836	RPT	A		30.32	199.27		F			0003	5200	1.4	boresight_bit=0
17:43:50.836	RPT	S		30.32	200.24		F		faa003	0003	5000	1.3	#ac=0 #rc=1 fs=0
17:43:55.445	RPT	A		30.14	199.42		F			0003	5300	1.4	boresight_bit=0
17:43:55.430	RPT	S		30.14	199.42		F		faa003	0003	5000	1.3	#ac=0 #rc=2 fs=0

Discussion 2 (for target FAA003):
The Terra match on TIS client FAA003 failed when the altitude difference between the two tracks (Mode S and ATCRBS) exceeded the altitude threshold (200 feet) starting at 17:43:41.594. TIS alerts were sent to the client FAA003 after three coasts.

Result 3:
The following results were obtained from analysis output file TERP2I.008, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	ATyp	Bear	Range	RelAlt
17:44:18.969	48.2	236.1	5000	0.1		faa006	263	N	T	0007	270	PROG	270.1	5.0	
17:44:23.586	48.1	236.3	5000	0.3	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-2750
										0007	270	PROG	269.8	5.0	
17:44:28.203	48.0	236.6	5000	0.1	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-2750
										0007	270	PROG	270.2	5.0	
17:44:32.820	47.8	236.8	5000	0.1	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-2750

.
.
.

17:46:19.023	45.1	242.4	5000	359.8	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-950
										0007	270	PROG	270.6	5.0	
17:46:23.641	45.0	242.7	5000	359.7	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-950
										0005	268	TIS	93.0	6.8	-1250
										0007	270	PROG	270.4	5.0	
										0005	268	PROG	90.8	6.9	
17:46:28.258	44.9	242.9	5000	359.9	3.0	faa006	263	N	T	0007	270	TIS	273.0	5.0	-850
										0005	268	TIS	93.0	6.8	-1250
.															
17:50:42.211	40.7	259.0	5000	360.0	3.0	faa006	263	N	T	0005	268	TIS	93.0	2.5	-1250
										0007	270	TIS	273.0	5.0	3250
										0005	268	PROG	90.0	2.5	
										0007	270	PROG	269.9	5.0	
17:50:46.820	40.7	259.4	5000	360.0	3.0	faa006	263	N	T	0005	268	TIS	93.0	2.5	-1250
										0007	270	TIS	273.0	5.0	3250
										0005	268	PROG	89.9	2.4	
										0007	270	PROG	269.9	5.0	
17:50:51.445	40.7	259.7	5000	0.1	3.0	faa006	263	N	T	0005	268	TIS	93.0	2.5	-1250
										0005	268	PROG	89.8	2.4	
										0007	270	PROG	269.7	5.0	

Discussion 3:
As shown in the above results, the TIS client (FAA006) received a TIS alert from target 0007 when target 0007 was at 2750 feet below the client FAA006 (occurred at 17:44:23.586). When target 0007 flew more than 3250 feet above the client FAA006, there was no alert sent to the client FAA006 from target 0007 (occurred after 17:50:46.820). The client FAA006 also received a TIS alert from target 0005 when target 0005 was at 6.8 nmi horizontally away from the client FAA006 (occurred at 17:46:23.641). Therefore, the results show that the TIS coverage volume was increased to 7 nmi range and +3500/-3000-foot altitude (Req: 230.1).

4.2.2.5 Results and Discussion for 68040 Platform.

Result 1:
The following results were obtained from analysis output file TERP2I.001, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa002	0		26	100.0	0		0	
2	faa001	0		33	100.0	0		0	
3	faa003	0		119	100.0	0		0	
4	*faa004*	*0*		*0*		*0*		*0*	
5	faa005	6	100.0	6	0.0	85	100.0	85	0.0
6	faa006	6	100.0	6	0.0	169	100.0	169	0.0
7	faa007	0		0		83	100.0	83	0.0
TOTAL		12	100.0	190	93.7	337	100.0	337	0.0

Number of antenna updates = 126
Number uncorrelated TIS advisory messages = 178
Number uncorrelated advisory messages = 0

Discussion 1:

As shown in the above results, the TIS client (FAA004) with unclear altitude received no TIS alert. Therefore, when either track lacks a clear altitude, the altitude difference between the tracks (Mode S and ATCRBS) was assumed to be 0. The result also shows that ATCRBS track (0004) did not generate any alert against the Mode S track (FAA004). It means the alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track (in order to prevent TIS self-alert).

Result 2:

Target FAA001:

The following results were obtained from analysis output files TERP2I.002, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
17:44:33.695	22.7	135.0	5000			faa001	13	N	T						
17:44:38.305	22.9	135.0	5000			faa001	13	N	T						
17:44:42.922	*23.1*	*135.0*	*5000*			*faa001*	*13*	*N*	*T*						
17:44:47.531	23.3	135.0	5000			faa001	13	N	T						
17:44:52.148	23.5	135.0	5000			faa001	13	N	T						
17:44:56.758	23.7	135.0	5000		135.0	faa001	13	N	T	0001	19	TIS	9.0	0.3	50
17:45:01.375	23.9	135.0	5000		141.0	faa001	13	N	T	0001	19	TIS	9.0	0.3	50

The following results were obtained from analysis output file TERP2I.003, which was generated from the Surveillance Print tool for the data of file TERP2I.DE:

Time-Of-Day	Cls	A S	Mo de	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
17:44:33.711	RPT	A		22.88	135.00		F			0001	5000	1.9	boresight_bit=0
17:44:33.695	RPT	S		22.71	135.02		F		faa001	0001	5000	1.9	#ac=0 #rc=1 fs=0
17:44:38.313	RPT	A		23.08	135.02		F			0001	5000	1.9	boresight_bit=0
17:44:38.305	RPT	S		22.90	135.02		F		faa001	0001	5000	1.9	#ac=0 #rc=1 fs=0
17:44:42.938	*RPT*	*A*		*23.28*	*135.02*		*F*			*0001*	*5000*	*1.8*	*boresight_bit=0*
17:44:42.922	*RPT*	*S*		*23.09*	*135.00*		*F*		*faa001*	*0001*	*5000*	*1.9*	*#ac=0 #rc=1 fs=0*
17:44:47.539	RPT	A		23.47	134.96		F			0001	5000	1.8	boresight_bit=0
17:44:47.531	RPT	S		23.29	134.96		F		faa001	0001	5000	1.8	#ac=0 #rc=1 fs=0
17:44:52.164	RPT	A		23.66	135.02		F			0001	5000	1.8	boresight_bit=0
17:44:52.148	RPT	S		23.48	134.96		F		faa001	0001	5000	1.8	#ac=0 #rc=1 fs=0
17:44:56.766	RPT	A		23.85	135.00		F			0001	5000	1.8	boresight_bit=0
17:44:56.758	RPT	S		23.66	135.00		F		faa001	0001	5000	1.8	#ac=0 #rc=1 fs=0
17:45:01.391	RPT	A		24.05	135.02		F			0001	5000	1.8	boresight_bit=0
17:45:01.375	RPT	S		23.86	135.02		F		faa001	0001	5000	1.8	#ac=0 #rc=2 fs=0

Discussion 2 (for target FAA001):
The Terra match on TIS client FAA001 failed when the range difference between the two tracks (Mode S and ATCRBS) exceeded the range threshold (.18 nmi) starting at 17:44:42.922. TIS alerts were sent to the client FAA001 after three coasts.

Target FAA002:

The following results were obtained from analysis output files TERP2I.004, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
17:44:38.875	12.5	180.0	19500			faa002	12	N	T						
17:44:43.492	12.3	180.0	19500			faa002	12	N	T						
17:44:48.109	*12.1*	*180.0*	*19500*			*faa002*	*12*	*N*	*T*						
17:44:52.727	11.9	180.0	19500			faa002	12	N	T						
17:44:57.336	11.7	180.0	19500			faa002	12	N	T						
17:45:01.945	11.6	180.0	19500		3.0	faa002	12	N	T	0002	20	TIS	93.0	0.3	50
17:45:06.563	11.4	180.0	19500		3.0	faa002	12	N	T	0002	20	TIS	93.0	0.3	50

The following results were obtained from analysis output file TERP2I.005, which was generated from the Surveillance Print tool for the data of file TERP2I.DE:

Time-Of-Day	Cls	A S	Mode	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
17:44:38.883	RPT	A		12.48	179.12		F			0002	19500	14.7	boresight_bit=0
17:44:38.875	RPT	S		12.48	179.96		F		faa002	0002	19500	14.7	#ac=0 #rc=1 fs=0
17:44:43.500	RPT	A		12.30	179.12		F			0002	19500	15.0	boresight_bit=0
17:44:43.492	RPT	S		12.30	179.98		F		faa002	0002	19500	15.0	#ac=0 #rc=1 fs=0
17:44:48.109	*RPT*	*A*		*12.11*	*179.10*		*F*			*0002*	*19500*	*15.2*	*boresight_bit=0*
17:44:48.109	*RPT*	*S*		*12.11*	*180.04*		*F*		*faa002*	*0002*	*19500*	*15.2*	*#ac=0 #rc=1 fs=0*
17:44:52.727	RPT	A		11.93	179.06		F			0002	19500	15.4	boresight_bit=0
17:44:52.727	RPT	S		11.93	180.02		F		faa002	0002	19500	15.4	#ac=0 #rc=1 fs=0
17:44:57.328	RPT	A		11.74	179.06		F			0002	19500	15.7	boresight_bit=0
17:44:57.336	RPT	S		11.74	180.00		F		faa002	0002	19500	15.7	#ac=0 #rc=1 fs=0
17:45:01.953	RPT	A		11.56	179.01		F			0002	19500	16.0	boresight_bit=0
17:45:01.945	RPT	S		11.55	179.96		F		faa002	0002	19500	16.0	#ac=0 #rc=1 fs=0
17:45:06.555	RPT	A		11.38	178.99		F			0002	19500	16.2	boresight_bit=0
17:45:06.563	RPT	S		11.38	180.00		F		faa002	0002	19500	16.2	#ac=0 #rc=2 fs=0

Discussion 2 (for target FAA002):
The Terra match on TIS client FAA002 failed when the azimuth difference between the two tracks (Mode S and ATCRBS) exceeded the azimuth threshold (.88°) starting at 17:44:48.109. TIS alerts were sent to the client FAA002 after three coasts.

Target FAA003:

The following results were obtained from analysis output files TERP2I.006, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
17:38:02.422	30.3	199.3	5000			faa003	14	N	T						
17:38:07.031	*30.1*	*199.5*	*5000*			*faa003*	*14*	*N*	*T*						
17:38:11.648	29.9	199.5	5000			faa003	14	N	T						
17:38:16.266	29.8	199.7	5000			faa003	14	N	T						
17:38:20.883	29.6	199.8	5000		3.0	faa003	14	N	T	0003	21	TIS	273.0	0.1	350
17:38:25.492	29.4	200.0	5000		3.0	faa003	14	N	T	0003	21	TIS	315.0	0.1	350

The following results were obtained from analysis output file TERP2I.007, which was generated from the Surveillance Print tool for the data of file TERP2I.DE:

Time-Of-Day	Cls	A S	Mo de	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
17:37:57.813	RPT	A		30.48	199.20		F			0003	5200	1.4	boresight_bit=0
17:37:57.805	RPT	S		30.48	199.25		F		faa003	0003	5000	1.3	#ac=0 #rc=2 fs=0
17:38:02.438	RPT	A		30.30	199.29		F			0003	5200	1.4	boresight_bit=0
17:38:02.422	RPT	S		30.29	199.31		F		faa003	0003	5000	1.3	#ac=0 #rc=1 fs=0
17:38:07.047	*RPT*	*A*		*30.12*	*199.45*		*F*			*0003*	*5300*	*1.5*	*boresight_bit=0*
17:38:07.031	*RPT*	*S*		*30.11*	*199.49*		*F*		*faa003*	*0003*	*5000*	*1.3*	*#ac=0 #rc=1 fs=0*
17:38:11.672	RPT	A		29.95	199.56		F			0003	5300	1.5	boresight_bit=0
17:38:11.648	RPT	S		29.93	199.53		F		faa003	0003	5000	1.4	#ac=0 #rc=1 fs=0
17:38:16.273	RPT	A		29.75	199.67		F			0003	5300	1.5	boresight_bit=0
17:38:16.266	RPT	S		29.75	199.67		F		faa003	0003	5000	1.4	#ac=0 #rc=1 fs=0
17:38:20.898	RPT	A		29.57	199.80		F			0003	5300	1.5	boresight_bit=0
17:38:20.883	RPT	S		29.57	199.82		F		faa003	0003	5000	1.4	#ac=0 #rc=1 fs=0
17:38:25.508	RPT	A		29.39	199.93		F			0003	5300	1.5	boresight_bit=0
17:38:25.492	RPT	S		29.39	199.95		F		faa003	0003	5000	1.4	#ac=0 #rc=2 fs=0

Discussion 2 (for target FAA003):

The Terra match on TIS client FAA003 failed when the altitude difference between the two tracks (Mode S and ATCRBS) exceeded the altitude threshold (200 feet) starting at 17:38:07.031. TIS alerts were sent to the client FAA003 after three coasts.

Result 3:

The following results were obtained from analysis output file TERP2I.008, which was generated from the TIS Analysis tool for the data of file TERP2I.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
17:38:21.336	48.5	235.6	5000	360.0		faa006	17	N	T	0007	25	PROG	270.3	5.0	
17:38:25.953	48.3	235.9	5000	359.9		faa006	17	N	T	0007	25	PROG	270.4	5.0	
17:38:30.570	48.2	236.1	5000	360.0		faa006	17	N	T	0007	25	PROG	270.3	5.0	
17:38:35.180	*48.1*	*236.3*	*5000*	*359.5*	*3.0*	*faa006*	*17*	*N*	*T*	*0007*	*25*	*TIS*	*273.0*	*5.0*	*-2750*
										0007	25	PROG	270.5	5.0	
17:38:39.805	47.9	236.6	5000	359.6	3.0	faa006	17	N	T	0007	25	TIS	273.0	5.0	-2750
										0007	25	PROG	270.3	5.0	
.															
.															
17:40:25.977	45.2	242.2	5000	0.0	3.0	faa006	17	N	T	0007	25	TIS	273.0	5.0	-1250
										0007	25	PROG	269.8	5.0	
17:40:30.594	45.1	242.4	5000	0.3	3.0	faa006	17	N	T	0007	25	TIS	273.0	5.0	-950

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
										0005	*23*	*TIS*	*93.0*	*6.8*	*-1250*
										0007	25	PROG	269.6	5.0	
										0005	23	PROG	89.7	6.9	
17:40:35.211	45.0	242.7	5000	0.1	3.0	faa006	17	N	T	0007	25	TIS	273.0	5.0	-950
										0005	23	TIS	93.0	6.8	-1250
										0007	25	PROG	269.9	5.0	
										0005	23	PROG	90.0	6.8	
.															
.															
17:44:58.344	40.7	259.4	5000	360.0	3.0	faa006	17	N	T	0005	23	TIS	93.0	2.5	-1250
										0007	*25*	*TIS*	*273.0*	*5.0*	*3250*
										0005	23	PROG	89.5	2.4	
										0007	25	PROG	270.1	5.0	
17:45:02.969	40.7	259.7	5000	0.1	3.0	faa006	17	N	T	0005	23	TIS	93.0	2.5	-1250
										0005	23	PROG	89.5	2.4	
										0007	25	PROG	270.0	5.0	

Discussion 3:
As shown in the above result, the TIS client (FAA006) received a TIS alert from target 0007 when target 0007 was at 2750 feet below the client FAA006 (occurred at 17:38:35.180). When target 0007 flew more than 3250 feet above the client FAA006, there was no alert sent to the client FAA006 from target 0007 (occurred after 17:44:58.344). The client FAA006 also received a TIS alert from target 0005 when target 0005 was at 6.8 nmi horizontally away from the client FAA006 (occurred at 17:40:30.594). Therefore, the results show that the TIS coverage volume was increased to 7 nmi range and +3500/-3000-foot altitude.

4.2.2.6 Conclusions.
As shown in results under the above two sections for both hardware platforms and builds, the following requirements were verified:

Req: 218.1 - When either track lacks a clear altitude, the altitude difference between the tracks (Mode S and ATCRBS) was assumed to be 0. See Result 1 under both sections above.

Req: 221.1 - The alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track. See Result 1 under both sections above.

Req: 214.1, 214.2 - The Terra match failed when the range difference between the two tracks (Mode S and ATCRBS) exceeded the range threshold (.18 nmi). See Result 2 under both sections above.

Req: 214.3, 215.1 - The Terra match failed when the azimuth difference between the two tracks (Mode S and ATCRBS) exceeded the azimuth threshold (.88°). See Result 2 under both sections above.

Req: 216.1, 217.1 - The Terra match failed when the altitude difference between the two tracks (Mode S and ATCRBS) exceeded the altitude threshold (200 feet). See Result 2 under both sections above.

Req: 225.5 - After three coasts, the reference track linkage was no longer trustworthy. See Result 2 under both sections above.

Req: 219.1, 220.1 - The Terra match was declared when the two tracks (Mode S and ATCRBS) had the same discrete mode-A codes and were close in range, azimuth, and altitude. See Result 2 under both sections above.

Req: 230.1 - The TIS coverage volume was increased to 7 nmi range and +3500/-3000-foot altitude. See Result 3 under both sections above.

4.2.3 Test Case #4: TIS Self-Alert Rate Reduction and TIS Performance.

4.2.3.1 Test Objective.

The objective of this test was to verify for both the 68020 and 68040 hardware platforms and builds that: (1) TIS self-alert generation had been eliminated or significantly reduced, (2) no real TIS alerts had been eliminated, and (3) general TIS performance had not been adversely affected by the TIS P2I software enhancement.

4.2.3.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.2.3.2-1.

TABLE 4.2.3.2-1. TEST CASE #4 CONFIGURATION

Sensor SW Version	Scenario(s)*	DE Files	DE Categories *
TIS P2I Test Releases (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	TISPERF1 TISPERF2	TISPERF1.DE TISPERF2.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

4.2.3.3 Data Collection and Analysis Method.

The RBAT TIS Analysis tool was used to obtain a summary/listing of TIS alerts/self-alerts. The results were used to compare to the results obtained from the Baseline Test Case (4.2.1.1) to determine the degree of success attained.

4.2.3.4 Results and Discussion for 68020 DPS Configuration.

Result 1:

The following results were obtained from analysis output file TISPERF1.001, which was generated from the TIS Analysis tool for the data of file TISPERF1.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa060	0		0		0		0	
2	faa100	0		0		5	100.0	5	0.0
3	faa200	0		0		6	100.0	6	0.0
4	faa005	36	97.2	35	0.0	91	100.0	91	0.0
5	faa006	36	97.2	35	0.0	90	100.0	90	0.0
6	faa003	0		0		39	100.0	39	0.0
7	faa004	1	100.0	1	0.0	38	100.0	38	0.0
8	faa040	11	100.0	11	0.0	230	100.0	230	0.0
9	faa001	0		0		0		0	
10	faa010	49	100.0	49	0.0	27	100.0	27	0.0
11	faa030	0		0		14	92.9	13	0.0
12	faa002	0		0		0		0	
13	faa020	0		0		15	93.3	14	0.0
14	faa050	11	100.0	11	0.0	234	100.0	234	0.0
15	faa070	0		0		0		0	
16	faa007	50	100.0	50	0.0	26	100.0	26	0.0
17	faa020	0		0		15	93.3	14	0.0
18	faa030	0		0		17	94.1	16	0.0
19	faa001	0		0		0		0	
20	faa001	0		0		0		0	
TOTAL		194	99.0	192	*0.0*	847	99.5	843	0.0

```
Number of antenna updates = 657
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 6
```

Discussion 1:
As shown in the above result, there were no (0 percent) false alerts (self-alerts) as contrasted to Result 1 of section 4.1.1, Current TIS Performance with 24.7 percent false alerts. With Terra mode enabled (by Site Adaptation Parameter (SAP) control), the alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track. The results also show that the Terra matching function had performed further checks on velocity to declare a Terra match on each of the nondiscrete targets (FAA001/ID=1200, FAA100/ID=0100, and FAA200/ID=0200) to prevent self-alerts.

Result 2:
The following results were obtained from analysis output file TISPERF2.001, which was generated from the TIS Analysis tool for the data of file TISPERF2.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa001	10	100.0	10	0.0	47	100.0	47	0.0
2	faa101	12	75.0	9	0.0	47	100.0	47	0.0
3	faa104	8	100.0	8	0.0	31	100.0	31	0.0
4	faa008	28	100.0	28	0.0	220	100.0	220	0.0
5	faa007	26	100.0	26	0.0	222	100.0	222	0.0
6	faa009	26	100.0	26	0.0	222	100.0	222	0.0
7	faa109	27	100.0	27	0.0	221	100.0	221	0.0
8	faa108	25	100.0	25	0.0	223	100.0	223	0.0
9	faa107	26	100.0	26	0.0	222	100.0	222	0.0
10	faa003	9	100.0	9	0.0	48	100.0	48	0.0
11	faa103	9	100.0	9	0.0	48	100.0	48	0.0
12	faa202	5	100.0	5	0.0	5	100.0	5	0.0
13	faa002	10	100.0	10	0.0	47	100.0	47	0.0
14	faa102	9	100.0	9	0.0	49	98.0	48	0.0
15	faa302	5	100.0	5	0.0	5	100.0	5	0.0
16	faa301	0		0		157	100.0	162	3.1
17	faa201	9	100.0	9	0.0	149	100.0	149	0.0
18	faa006	9	100.0	9	0.0	32	100.0	32	0.0
19	faa004	8	100.0	8	0.0	33	100.0	33	0.0
20	faa005	8	100.0	8	0.0	32	100.0	32	0.0
21	faa105	7	100.0	7	0.0	32	100.0	32	0.0
22	faa106	9	100.0	9	0.0	32	100.0	32	0.0
23	faa203	0		0		27	100.0	27	0.0
24	faa303	0		0		27	100.0	27	0.0
TOTAL		285	98.9	282	*0.0*	2178	100.0	2182	0.2

```
Number of antenna updates = 256
Number uncorrelated TIS advisory messages = 5
Number uncorrelated advisory messages = 4
```

Discussion 2:
As shown in the above result, there were no (0 percent) false alerts (self-alerts) as contrasted to Result 2 of section 4.1.1, Current TIS Performance with 3.8 percent false alerts.

4.2.3.5 Results and Discussion for 68040 DPS Configuration.

Result 1:
The following results were obtained from analysis file TISPERF1.001, which was generated from the TIS Analysis tool for the data of file TISPERF1.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa004	2	100.0	2	0.0	43	100.0	43	0.0
3	faa100	0		0		5	100.0	5	0.0
4	faa200	0		0		6	100.0	6	0.0
5	faa005	36	100.0	36	0.0	91	100.0	91	0.0
6	faa006	35	100.0	35	0.0	91	100.0	91	0.0
7	faa003	0		0		40	100.0	41	2.4
8	faa001	0		0		0		0	
9	faa010	49	100.0	49	0.0	27	100.0	27	0.0
10	faa030	0		0		14	100.0	14	0.0
11	faa020	0		0		15	100.0	15	0.0
12	faa002	0		0		0		0	
13	faa050	12	100.0	12	0.0	231	100.0	231	0.0
14	faa040	12	100.0	12	0.0	228	100.0	228	0.0
15	faa007	50	100.0	50	0.0	26	100.0	26	0.0
16	faa020	0		0		15	100.0	15	0.0
17	faa030	0		0		17	100.0	17	0.0
19	faa001	0		0		0		0	
20	faa001	0		0		0		0	
TOTAL		196	100.0	196	*0.0*	849	100.0	850	0.1

Number of antenna updates = 658
Number uncorrelated TIS advisory messages = 1
Number uncorrelated advisory messages = 0

Discussion 1:
As shown in the above result, there were no (0 percent) false alerts (self-alerts) as contrasted to Result 1 of section 4.1.1, Current TIS Performance with 24.7 percent false alerts. With Terra mode enabled (by SAP control), the alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track. The results also show that the Terra matching function had performed further checks on velocity to declare a Terra match on each of the nondiscrete targets (FAA001/ID=1200, FAA100/ID=0100, and FAA200/ID=0200) to prevent self-alerts.

Result 2:
The following results were obtained analysis output file TISPERF2.001, which was generated from the TIS Analysis tool for the data of file TISPERF2.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa001	10	100.0	10	0.0	47	100.0	47	0.0
2	faa101	10	100.0	10	0.0	47	100.0	47	0.0
3	faa005	3	100.0	3	0.0	38	100.0	38	0.0
4	faa004	4	100.0	4	0.0	37	100.0	37	0.0
5	faa104	3	100.0	3	0.0	38	100.0	38	0.0
6	faa105	3	100.0	3	0.0	38	100.0	38	0.0
7	faa106	9	100.0	9	0.0	32	100.0	32	0.0
8	faa007	30	90.0	27	0.0	226	98.7	223	0.0
9	faa009	0		0		247	100.0	247	0.0
10	faa008	0		0		247	100.0	247	0.0
11	faa109	0		0		247	100.0	247	0.0

12	faa108	0		0		247	100.0	247	0.0
13	faa107	26	100.0	26	0.0	222	100.0	222	0.0
14	faa003	9	100.0	9	0.0	48	100.0	48	0.0
15	faa103	9	100.0	9	0.0	48	100.0	48	0.0
16	faa202	5	100.0	5	0.0	5	100.0	5	0.0
17	faa002	9	100.0	9	0.0	47	100.0	47	0.0
18	faa102	9	100.0	9	0.0	48	100.0	48	0.0
19	faa302	5	100.0	5	0.0	5	100.0	5	0.0
20	faa201	11	72.7	8	0.0	145	98.6	143	0.0
21	faa301	5	40.0	2	0.0	155	96.8	150	0.0
22	faa006	9	100.0	9	0.0	32	100.0	32	0.0
23	faa203	0		0		27	100.0	27	0.0
24	faa303	0		0		27	100.0	27	0.0
TOTAL		169	94.7	160	*0.0*	2300	99.6	2290	0.0

```
Number of antenna updates = 258
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 19
```

Discussion 2:
As shown in the above result, there were no (0 percent) false alerts (self-alerts) as contrasted to Result 2 of section 4.1.1, Current TIS Performance with 3.8 percent false alerts.

4.2.3.6 Conclusions.

As shown in results under the above two sections for both hardware platforms and builds, the following requirements were verified:

Req: 211.1 - With Terra mode enabled (by SAP control), the alert determination process had performed additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of input track. See Results 1 and 2 under both sections above.

Req: 222.1, 223.1, 223.2 - For tracks with nondiscrete mode-A codes, the Terra matching function had performed further checks on velocity to prevent self-alert. See Result 1 under both sections above.

As shown in Results 1 and 2 for both hardware platforms, there were no (0 percent) self-alerts as contrasted to section 4.1.1, Current TIS Performance with 24.7 percent false alert found on TISPERF1.SEN and 3.8 percent false alerts found on TISPERF2.SEN. The results show that with TIS P2I enhancement present and operational, the problem with the false alerts (self-alerts) that occurred on the current fielded version has been eliminated. Compared to test results under section 4.3.4, Non-Terra Mode Operation, there was no significant reduction of TIS alerts. With TIS P2I enhancement present and operational, there was no adverse effect to the general TIS performance.

4.2.4 Test Case #5: Elimination of CPME as Intruder.

4.2.4.1 Test Objective.

The objective of this test was to verify that the CPME did not generate TIS alerts to the nearby TIS client aircraft on either hardware platform and build.

4.2.4.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.2.4.2-1.

TABLE 4.2.4.2-1. TEST CASE #5 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Releases (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	CPMEB	CPMEB.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

4.2.4.3 Data Collection and Analysis Method.

The RBAT TIS Analysis tool was used to obtain a summary of TIS alerts.

4.2.4.4 Results and Discussion for 68020 DPS Configuration.

Result 1:

The following results were obtained from analysis output file CPMEB.001, which was generated from the TIS Analysis tool for the data of file CPMEB.DE:

	Mode S	----Traffic Advisory---			---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa001	0		0		32	100.0	32	0.0
2	faa002	0		0		80	0.0	0	
TOTAL		0		0		112	28.6	32	0.0

Number of antenna updates = 112
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 80

Discussion 1:

As shown in the above result, there was no TIS alert, neither Traffic Advisory nor Proximity Advisory alert, generated to the nearby TIS clients (FAA001 and FAA002) from the CPMEs (0202 and 0204). There were 32 TIS (Proximity Advisory) alerts generated to the client FAA001 from a simulated target inserted next to the CPME 0202 for checking on the alert determination process function.

4.2.4.5 Results and Discussion for 68040 DPS Configuration.

Result 1:

The following results were obtained from analysis output file CPMEB.001, which was generated from the TIS Analysis tool for the data of file CPMEB.DE:

	Mode S	----Traffic Advisory---			---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa002	0		0		78	0.0	0	
2	faa001	0		0		0		0	
TOTAL		0		0		78	0.0	0	

```
Number of antenna updates = 81
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 78
```

Discussion 1:
As shown in the above result, there was no TIS alert, neither Traffic Advisory nor Proximity Advisory alert, generated to the nearby TIS clients (FAA001 and FAA002) from the CPMEs (0202 and 0204).

4.2.4.6 Conclusions.

As shown in results under the above two sections for both hardware platforms and builds, the following requirement was verified:

Req: 194.1 - All CPME tracks found were ignored in the coarse screening process. See result 1 under both sections above.

4.3 REGRESSION TEST PHASE.

The primary focus of this test phase was to verify on the existing TIS requirements and to ensure that the TIS P^2I software enhancements did not degrade performance, nor had any negative side-effects.

4.3.1 Test Case #6: SAPs and TIS Service Request.

4.3.1.1 Test Objective.

The objective of this test was to verify that the TIS service requests from aircraft were handled correctly and that the TIS SAPs correctly controlled the operation of the Terra/TIS processing.

4.3.1.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.3.1.2-1.

TABLE 4.3.1.2-1. TEST CASE #6 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Release (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	TISPERF1	TISPERF1.DE	2, 5,6, 9-10, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

Before running the scenario, all TIS SAPs installed on sensor were verified and ensured that the SAP values were correctly set on the LMT. The scenario was run in both TIS enabled and TIS disabled mode.

4.3.1.3 Data Collection and Analysis Method.

The RBAT TIS Analysis and Miscellaneous Print tools were used to obtain a listing of TIS alerts and alert messages generated for uplink to the TIS client.

4.3.1.4 Results and Discussion for 68020 DPS Configuration.

Result 1:
The following results were obtained from analysis output file TISPERF1.002, which was generated from the Miscellaneous Print tool for the data of file TISPERF1.DE:

```
15:16:29.547 scan=150 type=90 TIS Report
15:16:29.367 rng=  2.195 azm=285.117 alt=   6500 type=0 gnd_rng=  1.912 x= -1.846 y=  0.501
z=6500
Mode S mdsid=faa020 aid=0020 trk=158 r_type=NORMAL ca=0 cpme=F mat=T tis=1

15:16:34.188 scan=151 type=90 TIS Report
15:16:34.008 rng=  1.962 azm=287.732 alt=   6500 type=0 gnd_rng=  1.639 x= -1.563 y=  0.501
z=6500
Mode S mdsid=faa020 aid=0020 trk=158 r_type=NORMAL ca=0 cpme=F mat=T tis=1

15:16:39.078 scan=152 type=90 TIS Report
15:16:38.672 rng=  1.735 azm=290.918 alt=   6500 type=0 gnd_rng=  0.000 x=  0.000 y=  0.000
z=6500
Mode S mdsid=faa020 aid=0020 trk=158 r_type= COAST ca=0 cpme=F mat=T tis=1

15:16:43.711 scan=153 type=90 TIS Report
15:16:43.328 rng=  1.522 azm=294.939 alt=   6500 type=0 gnd_rng=  0.000 x=  0.000 y=  0.000
z=6500
Mode S mdsid=faa020 aid=0020 trk=158 r_type= COAST ca=0 cpme=F mat=T tis=1
```

Discussion 1:
Target FAA020 coasted at 15:16:38.672 after flying into the TIS Zenith Cone, which was set to 34° for the Zenith Cone Angle.

Result 2:
The following results were obtained from analysis output file TISPERF1.003, which was generated from the TIS Analysis tool for the data of file TISPERF1.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
15:14:14.375	20.3	192.8	6000	160.4		faa006	136	N	T	0005	138	PROG	19.8	1.6	456
15:14:18.984	20.5	192.3	6000	160.4	165.0	faa006	136	N	T	0005	138	TIS	21.0	1.3	550
										0005	138	PROG	19.7	1.3	463

Discussion 2:
As shown in the above result, only ATCRBS track 0005 was sent to alert determination process.

4.3.1.5 Results and Discussion for 68040 DPS Configuration.

Result 1:
The following results were obtained from analysis output file TISPERF1.002, which was generated from the Miscellaneous Print tool for the data of file TISPERF1.DE:

```
16:03:41.656 scan=78 type=90 TIS Report
16:03:41.453 rng=  2.225 azm=284.854 alt=   6500 type=0 gnd_rng=  1.952 x= -1.886 y=  0.501
z=6500
Mode S mdsid=faa020 aid=0020 trk=19 r_type=NORMAL ca=0 cpme=F mat=T tis=1

16:03:46.305 scan=79 type=90 TIS Report
```

```
16:03:46.102 rng=  1.987 azm=287.292 alt=   6500 type=0 gnd_rng=  1.669 x= -1.593 y=  0.496
z=6500
Mode S mdsid=faa020 aid=0020 trk=19 r_type=NORMAL ca=0 cpme=F mat=T tis=1

16:03:51.156 scan=80 type=90 TIS Report
16:03:50.758 rng=  1.755 azm=290.237 alt=   6500 type=0 gnd rng=  0.000 x=  0.000 y=  0.000
z=6500
Mode S mdsid=faa020 aid=0020 trk=19 r_type= COAST ca=0 cpme=F mat=T tis=1

16:03:55.805 scan=81 type=90 TIS Report
16:03:55.414 rng=  1.537 azm=293.818 alt=   6500 type=0 gnd_rng=  0.000 x=  0.000 y=  0.000
z=6500
Mode S mdsid=faa020 aid=0020 trk=19 r_type= COAST ca=0 cpme=F mat=T tis=1
```

Discussion 1:
Target FAA020 coasted at 16:03:50.758 after flying into the TIS Zenith Cone, which was set to 34° Angle.

Result 2:
The following results were obtained from analysis output file TISPERF1.003, which was generated from the TIS Analysis tool for the data of file TISPERF1.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
16:01:26.445	20.3	192.8	6000	160.4	165.0	faa006	6	N	T	0005	7	TIS	21.0	1.8	550
										0005	7	PROG	19.7	1.6	454
16:01:31.063	20.5	192.4	6000	160.3	165.0	faa006	6	N	T	0005	7	TIS	21.0	1.5	550

Discussion 2:
As shown in the above result, only ATCRBS track 0005 was sent to alert determination process.

4.3.1.6 Conclusions.
As shown in results under the above two sections for both the hardware platforms and builds, the following requirements were verified:

Req: 34.0, 36.0, 37.0 - The parameter "TIS Zenith Cone Angle" in the SAP table controlled the operation of Terra/TIS processing (see Result 1 under both sections above). When the TIS flag was disabled by SAP control, there was no TIS service for the TIS client.

Req: 200.0 - When Terra mode was enabled by SAP control, only ATCRBS tracks were sent to alert determination process. See Result 2 under both sections above.

4.3.2 Test Case #7: TIS Messages, Message Types, and Message Formats.

4.3.2.1 Test Objective.
The objective of this test was to verify the alert messages, message types, and message formats generated for an uplink to the TIS client (TIS-equipped aircraft).

4.3.2.2 Test Description.
This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.3.2.2-1.

TABLE 4.3.2.2-1. TEST CASE #7 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Release (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	TIS4411 TIS4422 TIS4423 TIS4424 TISPERF1 TISPERF2	TIS4411.DE TIS4422.DE TIS4423.DE TIS4424.DE TISPERF1.DE TISPERF2.DE	2, 5,6, 9-10, and 89-92

* NOTE: see appendix B scenario descriptions and appendix C for DE definitions

4.3.2.3 Data Collection and Analysis Method.

The RBAT TIS Analysis and Miscellaneous Print tools were used to obtain a summary of TIS alerts and alert messages generated for an uplink to the TIS client.

4.3.2.4 Results and Discussion for 68020 DPS Configuration.

Result 1:

The following results were obtained from analysis output file TIS4424.001, which was generated from the Miscellaneous Print tool for the data of file TIS4424.DE:

```
16:34:26.344 scan=162 type=91 TIS Alert
16:34:26.328 mdsid=faa001 sfn=137 #alerts=8 #msgs=4 bye=F
header=2 msg_type=16 block[ 0] =040975 block[ 1] =1095b5
header=2 own_ac_heading=99
intruder 1: sfn=123 tau_h=120 tau_v=-1 bearing= 51 rng=0.2500 alt=    550 alt_rate=     Level
heading=112.5   Traffic
intruder 2: sfn=129 tau_h=839 tau_v=-1 bearing=201 rng=0.5000 alt=   -550 alt_rate=     Level
heading=112.5   Traffic
header=2 msg_type=60 block[ 0] =0fa2b2 block[ 1] =0236f6
intruder 3: sfn=112 tau_h=805 tau_v=-1 bearing=189 rng=1.0000 alt=   1250 alt_rate=     Level
heading= 67.5 Proximate
intruder 4: sfn=121 tau_h=-102 tau_v=-1 bearing= 27 rng=1.5000 alt=  -1250 alt_rate=     Level
heading=157.5 Proximate
header=2 msg_type=60 block[ 0] =0136b4 block[ 1] =0fc874
intruder 5: sfn=116 tau_h=-5030 tau_v=-9999 bearing= 15 rng=1.5000 alt=   -950 alt_rate=
Level heading=112.5 Proximate
intruder 6: sfn=132 tau_h=-536 tau_v=-9999 bearing=189 rng=2.5000 alt=    150 alt_rate=     Level
heading=112.5 Proximate
header=2 msg_type=61 block[ 0] =1d5db4 block[ 1] =0f62b4
intruder 7: sfn=128 tau_h=13800 tau_v=-9999 bearing=351 rng=3.8750 alt=   -550 alt_rate=
Level heading=112.5 Proximate
intruder 8: sfn=122 tau_h=-5257 tau_v=-9999 bearing=183 rng=5.0000 alt=   1250 alt_rate=
Level heading=112.5 Proximate
```

Discussion 1:

As shown in the above result, TIS alert messages were determined as "threat (traffic)" or "proximity (proximate)" advisories. The result also shows that TIS alert messages passed to the TIS message formation processing for a given TIS-equipped aircraft were limited to eight alert messages. The TIS alert messages were correctly generated in a format of 8-bit MSP Header, 6-bit Message Type, and two 21-bit Traffic Data Blocks, and were sent to the TIS client aircraft in priority order. The individual alert messages were grouped together. The message type was set

to 60 for an intermediate group, to 61 for the final group, and to the own-aircraft ground track angle for the first message in each group.

Result 2:
The following results were obtained from analysis output file TIS4423.001, which was generated from the Miscellaneous Print tool for the data of file TIS4423.DE:

```
16:20:17.641 scan=234 type=91 TIS Alert
16:20:17.625 mdsid=faa001 sfn=69 #alerts=3 #msgs=2 bye=F
header=2 msg_type=15 block[ 0] =038835 block[ 1] =1c0835
header=2 own_ac_heading=93
intruder 1: sfn= 74 tau_h=25 tau_v=-1 bearing= 45 rng=0.2500 alt=     50 alt_rate=     Level
heading=112.5   Traffic
intruder 2: sfn= 76 tau_h=-1 tau_v=-1 bearing=339 rng=0.2500 alt=     50 alt_rate=     Level
heading=112.5   Traffic
header=2 msg_type=61 block[ 0] =00ccf4 block[ 1] =1f8000
intruder 3: sfn= 75 tau_h=2139 tau_v=-9999 bearing=  9 rng=2.5000 alt=   -250 alt_rate=     Level
heading=112.5 Proximate
```

Discussion 2:
As shown in the above result, the message type was set to 61 for the final group and was set as own-aircraft ground track angle for the first message in each group. For one traffic aircraft in the TIS message, the Traffic Bearing field in the unused Traffic Information Block (block[1]) was set to the value 63 and the remainder of the bits were cleared to 0.

Result 3:
The following results were obtained from analysis output file TISPERF2.002, which was generated from the Miscellaneous Print tool for the data of file TISPERF2.DE:

```
14:55:40.742 scan=136 type=91 TIS Alert
14:55:40.734 mdsid=faa203 sfn=105 #alerts=1 #msgs=1 bye=F
header=2 msg_type=15 block[ 0] =157930 block[ 1] =1f8000
header=2 own_ac_heading=93
intruder 1: sfn=120 tau_h=-67 tau_v=-9999 bearing=255 rng=7.0000 alt=    450 alt_rate=     Level
heading= 22.5 Proximate

14:55:45.344 scan=137 type=91 TIS Alert
14:55:45.336 mdsid=faa203 sfn=105 #alerts=0 #msgs=1 bye=F
header=2 msg_type=63 block[ 0] =000000 block[ 1] =000000
Keep alive message

14:56:40.867 scan=149 type=91 TIS Alert
14:56:40.859 mdsid=faa203 sfn=105 #alerts=0 #msgs=1 bye=F
header=2 msg_type=63 block[ 0] =000000 block[ 1] =000000
Keep alive message
```

Discussion 3:
As shown in the above result, the message type was set to 63 for the Keep Alive message. The Keep Alive message was generated for uplink to the TIS client at least every 60 seconds minus one-scan interval (from 14:55:45.336 to 14:56:40.859). The information about the altitude rate of the intruder (FAA303/ID=3003) was indicated as "level" (450 feet/min) when sending to the client FAA203. The result shows that the threshold of the altitude rate should be 500 feet/min.

Result 4:
The following results were obtained from analysis output file TISPERF1.004, which was generated from the Miscellaneous Print tool for the data of file TISPERF1.DE:

```
15:16:25.898 scan=150 type=91 TIS Alert
15:16:25.891 mdsid=faa020 sfn=158 #alerts=1 #msgs=1 bye=T
header=2 msg type=62 block[ 0] =000000 block[ 1] =000000
Goodbye message
```

Discussion 4:
As shown in the above result, the message type was set to 62 for the Good Bye message. The Good Bye message was generated for an uplink to the client when the client is relocated into the sensor's TIS zenith cone. The Good Bye message contained two 21-bit Traffic Information blocks (block[0] and block[1]), which were unused and cleared to zero.

Result 5:
The following results were obtained from analysis output file TISPERF2.001, which was generated from the TIS Analysis tool for the data of file TISPERF2.DE:

			Reliability				
Size	Bear	Size	Range	Alt	ARate	Head	Stat
57	89.5	57	100.0	100.0	93.0	100.0	100.0
56	98.2	56	100.0	100.0	100.0	100.0	100.0
36	100.0	39	100.0	0.0	0.0	100.0	87.2
228	99.1	248	100.0	63.3	60.5	99.6	89.5
228	99.6	248	99.6	77.4	77.4	99.2	99.2
226	98.7	248	99.2	29.0	28.2	98.8	89.5
228	99.6	248	99.2	29.0	29.0	99.6	89.1
229	99.6	248	100.0	63.3	63.3	100.0	89.9
231	99.6	248	100.0	77.0	77.0	100.0	99.6
57	96.5	57	100.0	68.4	100.0	100.0	100.0
57	98.2	57	100.0	68.4	100.0	100.0	100.0
10	100.0	10	100.0	0.0	0.0	100.0	100.0
57	98.2	57	100.0	100.0	93.0	100.0	100.0
57	96.5	57	100.0	100.0	100.0	100.0	100.0
10	100.0	10	100.0	0.0	0.0	100.0	100.0
147	100.0	157	99.4	45.9	46.5	100.0	100.0
149	99.3	158	98.7	39.2	36.7	100.0	98.1
38	100.0	41	100.0	100.0	100.0	100.0	100.0
39	100.0	41	97.6	0.0	0.0	100.0	90.2
37	100.0	40	100.0	0.0	0.0	100.0	90.0
36	100.0	39	100.0	0.0	0.0	100.0	89.7
39	100.0	41	100.0	100.0	100.0	100.0	100.0
27	85.2	27	100.0	0.0	0.0	100.0	100.0
27	100.0	27	100.0	0.0	0.0	100.0	100.0
TOT 2306	98.8	2459	99.6	55.4	56.0	99.7	94.8

```
Number of antenna updates = 256
Number uncorrelated TIS advisory messages = 5
Number uncorrelated advisory messages = 4
```

Discussion 5:
The percentages of reliability on Relative Bearing, Relative Range, Relative Altitude, Intruder Altitude Rate, Intruder Heading, and Alert State were 90 percent or more for over the entire scenario. The results show that the TIS uplink messages were correct and reliable.

4.3.2.5 Results and Discussion for 68040 DPS Configuration.

Result 1:
The following results were obtained from analysis output file TIS4424.001, which was generated from the Miscellaneous Print tool for the data of file TIS4424.DE:

```
18:25:46.914 scan=153 type=91 TIS Alert
18:25:46.898 mdsid=faa001 sfn=124 #alerts=8 #msgs=4 bye=F
header=2 msg_type=16 block[ 0] =38975 block[ 1] =1095b5
header=2 own_ac_heading=99
intruder 1: sfn=122 tau_h=-188 tau_v=-1 bearing= 45 rng=0.2500 alt=    550 alt_rate=     Level
heading=112.5   Traffic
intruder 2: sfn=127 tau_h=-539 tau_v=-1 bearing=201 rng=0.5000 alt=   -550 alt_rate=     Level
heading=112.5   Traffic
header=2 msg_type=60 block[ 0] =da2b2 block[ 1] =1c26f6
intruder 3: sfn=111 tau_h=76 tau_v=-1 bearing=165 rng=1.0000 alt=   1250 alt_rate=     Level
heading= 67.5 Proximate
intruder 4: sfn=118 tau_h=100 tau_v=-1 bearing=339 rng=1.0000 alt=  -1250 alt_rate=     Level
heading=157.5 Proximate
header=2 msg_type=60 block[ 0] =136b4 block[ 1] =fc874
intruder 5: sfn=110 tau_h=-32809 tau_v=-9999 bearing= 15 rng=1.5000 alt=   -950 alt_rate=
Level heading=112.5 Proximate
intruder 6: sfn=126 tau_h=-260 tau_v=-9999 bearing=189 rng=2.5000 alt=    150 alt_rate=     Level
heading=112.5 Proximate
header=2 msg_type=61 block[ 0] =1d5db4 block[ 1] =f5ab4
intruder 7: sfn=125 tau_h=-8737 tau_v=-9999 bearing=351 rng=3.8750 alt=   -550 alt_rate=
Level heading=112.5 Proximate
intruder 8: sfn=121 tau_h=4469 tau_v=-9999 bearing=183 rng=3.8750 alt=   1250 alt_rate=     Level
heading=112.5 Proximate
```

Discussion 1:
As shown in the above result, TIS alert messages were determined as "threat (traffic)" or "proximity (proximate)" advisories. The result also shows that TIS alert messages passed to the TIS message formation processing for a given TIS-equipped aircraft were limited to eight alert messages. The TIS alert messages were correctly generated in a format of 8-bit MSP Header, 6-bit Message Type, and two 21-bit Traffic Data Blocks, and were sent to the TIS client aircraft in priority order. The individual alert messages were grouped together. The message type was set to 60 for an intermediate group, to 61 for the final group, and to the own-aircraft ground track angle for the first message in each group.

Result 2:
The following results were obtained from analysis output file TIS4423.001, which was generated from the Miscellaneous Print tool for the data of file TIS4423.DE:

```
18:12:19.555 scan=234 type=91 TIS Alert
18:12:19.547 mdsid=faa001 sfn=69 #alerts=3 #msgs=2 bye=F
header=2 msg_type=15 block[ 0] =1b8835 block[ 1] =18835
header=2 own_ac_heading=93
intruder 1: sfn= 77 tau_h=110 tau_v=-1 bearing=333 rng=0.2500 alt=     50 alt_rate=     Level
heading=112.5   Traffic
intruder 2: sfn= 72 tau_h=1885 tau_v=-1 bearing= 21 rng=0.2500 alt=     50 alt_rate=     Level
heading=112.5   Traffic
header=2 msg_type=61 block[ 0] =4cf4 block[ 1] =1f8000
intruder 3: sfn= 73 tau_h=681 tau_v=-9999 bearing=  3 rng=2.5000 alt=   -250 alt_rate=     Level
heading=112.5 Proximate
```

Discussion 2:
As shown in the above result, the message type was set to 61 for the final group and was set as own-aircraft ground track angle for the first message in each group. For one traffic aircraft in the TIS message, the Traffic Bearing field in the unused Traffic Information Block (block[1]) was set to the value 63 and the remainder of the bits were cleared to 0.

Result 3:
The following results were obtained from analysis output file TISPERF2.002, which was generated from the Miscellaneous Print tool for the data of file TISPERF2.DE:

```
15:08:30.273 scan=132 type=91 TIS Alert
15:08:30.266 mdsid=faa203 sfn=45 #alerts=1 #msgs=1 bye=F
header=2 msg type=15 block[ 0] =157930 block[ 1] =1f8000
header=2 own_ac_heading=93
intruder 1: sfn= 62 tau h=-68 tau v=-9999 bearing=255 rng=7.0000 alt=    450 alt rate=     Level
heading= 22.5 Proximate

15:08:34.906 scan=133 type=91 TIS Alert
15:08:34.898 mdsid=faa203 sfn=45 #alerts=0 #msgs=1 bye=F
header=2 msg type=63 block[ 0] =0 block[ 1] =0
Keep alive message

15:09:30.422 scan=145 type=91 TIS Alert
15:09:30.414 mdsid=faa203 sfn=45 #alerts=0 #msgs=1 bye=F
header=2 msg type=63 block[ 0] =0 block[ 1] =0
Keep alive message
```

Discussion 3:
As shown in the above result, the message type was set to 63 for the Keep Alive message. The Keep Alive message was generated for uplink to the TIS client at least every 60 seconds minus one-scan interval (from 15:08:34.898 to 15:09:30.414). The information about the altitude rate of the intruder (FAA303/ID=3003) was indicated as "level" (450ft/min) when sending to the client FAA203. The result shows that the threshold of the altitude rate should be 500 feet/min.

Result 4:
The following results were obtained from analysis output file TISPERF1.004, which was generated from the Miscellaneous Print tool for the data of file TISPERF1.DE:

```
16:03:37.977 scan=78 type=91 TIS Alert
16:03:37.977 mdsid=faa020 sfn=19 #alerts=1 #msgs=1 bye=T
header=2 msg type=62 block[ 0] =0 block[ 1] =0
Goodbye message
```

Discussion 4:
As shown in the above result, the message type was set to 62 for the Good Bye message. The Good Bye message was generated for an uplink to the client when the client is relocated into the sensor's TIS zenith cone. The Good Bye message contained two 21-bit Traffic Information blocks (block[0] and block[1]), which were unused and cleared to zero.

Result 5:
The following results were obtained from analysis output file TISPERF2.001, which was generated from the TIS Analysis tool for the data of file TISPERF2.DE:

Reliability							
Size	Bear	Size	Range	Alt	ARate	Head	Stat
57	98.2	57	100.0	94.7	91.2	100.0	100.0
57	100.0	57	100.0	96.5	96.5	100.0	100.0
38	100.0	41	100.0	100.0	95.1	100.0	97.6
38	100.0	41	100.0	100.0	95.1	100.0	100.0
39	100.0	41	100.0	100.0	100.0	100.0	100.0
38	100.0	41	100.0	100.0	100.0	100.0	100.0
39	100.0	41	100.0	100.0	100.0	100.0	100.0
231	96.5	250	100.0	100.0	100.0	100.0	99.6
228	100.0	247	100.0	100.0	97.6	100.0	100.0
228	99.6	247	99.6	99.2	96.0	100.0	99.2
228	100.0	247	99.6	100.0	100.0	100.0	100.0
227	100.0	247	100.0	100.0	100.0	100.0	100.0
231	100.0	248	99.6	100.0	100.0	100.0	99.2
57	100.0	57	100.0	100.0	100.0	100.0	100.0
57	100.0	57	100.0	100.0	100.0	100.0	100.0
10	100.0	10	100.0	100.0	100.0	100.0	100.0
56	100.0	56	100.0	100.0	83.9	100.0	100.0
57	100.0	57	100.0	100.0	100.0	100.0	100.0
10	100.0	10	100.0	100.0	100.0	100.0	100.0
142	99.3	151	98.7	97.4	85.4	100.0	98.0
141	100.0	152	98.7	98.7	97.4	100.0	98.7
39	100.0	41	100.0	100.0	100.0	100.0	100.0
27	100.0	27	100.0	100.0	100.0	100.0	100.0
27	100.0	27	100.0	100.0	100.0	100.0	100.0
Total 2302	*99.5*	*2450*	*99.7*	*99.5*	*97.5*	*100.0*	*99.6*

```
Number of antenna updates = 258
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 19
```

Discussion 5:
The percentages of reliability on Relative Bearing, Relative Range, Relative Altitude, Intruder Altitude Rate, Intruder Heading, and Alert State were 90 percent or more for over the entire scenario. The result shows that the TIS uplink messages were reliably correct.

4.3.2.6 Conclusions.
As shown in results under the above two sections for both hardware platforms and builds, the following requirements were verified:

Req: 228.0, 230.1 - TIS alert messages were determined as "threat (traffic)" or "proximity (proximate)" indicators as specified in the requirements. See Result 1 under both sections above.

Req: 260.0 - TIS alert messages passed to the TIS message formation processing for a given TIS equipped aircraft were limited to eight alert messages. See Result 2 under both sections above.

Req: 232.0, 233.0, 259.0 - The TIS alert messages were correctly generated in a format of 8-bit MSP Header, 6-bit Message Type, and two 21-bit Traffic Data Blocks and were sent to the TIS client aircraft in priority order. See Result 1 under both sections above.

Req: 262.0, 264.0, 270.0, 271.0 - The individual alert messages were grouped together. The message type was set to 60 for an intermediate group, set to 61 for the final group, and set as own-aircraft ground track angle for the first message in each group. See Result 1 under both sections above.

Req: 274.0, 277.0, 279.0, 283.0, 287.0, 289.0, 292.0, 294.0 - There were two 21-bit Traffic Information Blocks for each Traffic Data message. Each block was verified to ensure that they meet requirements. See Results 1 and 2 under both sections above.

Req: 281.0, 282.0 - When there was one traffic aircraft used in a given TIS message, the second Traffic Information Block was unused. The Traffic Bearing field in that unused block was set to 63 (representing a bearing angle greater than 360°) and the remainder of the bits in that unused block was cleared to 0. See Result 2 under both sections above.

Req: 290.0 - An altitude rate of 500 feet/min was used as a threshold. See Result 3 under both sections above.

Req: 272.0, 295.0 - The message type was set to 63 for the Keep Alive message, which was generated for uplink to the TIS client as specified in the requirement. See Result 3 under both sections above.

Req 273.0, 298.0, 300.0 - The message type was set to 62 for the Good Bye message, which was generated for uplink to the client as specified in the requirement. The Good Bye message contained two 21-bit Traffic Information blocks, which were unused and cleared to zero. See Result 4 under both sections above.

Req: 355.0, 356.0, 356.5, 357.0, 358.0 and 359.0 - The percentages of reliability on Relative Bearing, Relative Range, Relative Altitude, Intruder Altitude Rate, Intruder Heading, and Alert State were about 90 percent or more for over the entire scenario. The result shows that the TIS uplink messages were reliably correct. See Result 5 under both sections above.

4.3.3 Test Case #8: CPU Utilization and Maximum TIS Clients.

4.3.3.1 Test Objective.

The objectives of this test were to determine to what value the "TIS Maximum Aircraft Supported" SAP should be set for field deployment, and to verify that TIS clients were limited to that number. Since the addition of four new TIS Performance Monitoring LU Data Points was not available on platform 68020, the addition of four new TIS Performance Monitoring LU Data Points was verified on the 68040 DPS configuration only.

4.3.3.2 Test Description.

This test was conducted by running Mode S sensor with ARIES scenario as configured in table 4.3.3.2-1.

TABLE 4.3.3.2-1. TEST CASE #8 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Categories *
TIS P2I Test Release (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Enabled	TISMAXC	N/A

* NOTE: see appendix B for scenario descriptions.

Since ARIES channel B was not operational, this test was performed on Mode S Channel A only. At each client (TIS target) level increment, the CPU utilization percentage of channel A on the Mode S processors was recorded. The scenario continued until the sensor processors passed 80 percent utilization. The "TIS Maximum Aircraft Supported" SAP was then set to the value that kept CPU utilization under 80 percent (determined from these test runs) to verify that the number of clients were limited to that number.

4.3.3.3 Data Collection and Analysis Method.

No formal data collection was required for this test.

4.3.3.4 Results and Discussion for 68020 DPS Configuration.

Result:

TABLE 4.3.3.4-1. CPU UTILIZATION ON 68020 DPS

	Percentage of Mode S CPU Utilization																			
CPU	0		1		2		3		4		5		6		7		11		13	
Target Load	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C
60	20	16	42	40	27	19	12	10	12	11	16	2	19	15	12	1	6	3	10	5
70	20	18	62	57	24	20	13	11	15	9	17	11	23	18	13	1	7	3	10	5
80	18	18	60	38	25	25	14	14	17	9	16	13	23	23	13	1	7	3	10	10
90	18	16	68	68	26	17	14	9	17	17	15	12	25	13	9	1	3	3	10	5
100	25	14	***82***	54	33	7	17	4	23	10	17	11	30	6	14	1	6	3	11	4
110	23	16	86	76	37	18	20	9	27	5	20	16	36	12	13	1	6	3	11	6
120	23	13	91	20	41	9	20	4	29	0	22	6	37	5	12	1	8	3	12	8

M = maximum percentage of CPU utilization, C = current percentage of CPU utilization.

Discussion:

The results as shown in the above table were collected from Mode S channel A. The CPU utilization percentage was measured above 80 percent in CPU 1 when 100 or more TIS targets were loaded.

4.3.3.5 Results and Discussion for 68040 DPS Configuration.

Result:

TABLE 4.3.3.5-1. CPU UTILIZATION ON 68040 DPS

	Percentage of Mode S CPU Utilization															
CPU	DP_0		DP_1		DP_2		DP_3		DP_4		MIOP		CIOP		SIOP	
Target Load	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C
80	10	9	49	20	52	48	15	7	22	19	19	3	7	3	12	10
90	10	8	49	37	57	16	15	14	23	14	18	13	7	4	12	11
100	10	10	49	24	63	47	15	6	23	23	18	4	7	3	12	10
110	10	9	49	45	68	23	15	15	23	20	19	11	7	4	12	11
120	10	7	51	7	68	13	15	1	24	6	19	4	7	3	12	10
130	10	8	51	27	76	18	16	16	25	13	19	10	7	5	12	11
140	10	10	51	24	79	66	16	10	25	23	19	4	7	3	12	11
150	10	8	51	13	***83***	70	16	13	25	12	19	1	7	3	12	8
160	10	10	51	27	91	63	17	8	25	25	19	4	7	3	13	11
170	10	8	51	12	93	73	17	13	25	11	19	7	7	3	13	8

M = maximum percentage of CPU utilization, C = current percentage of CPU utilization.

Discussion:
The results as shown in the above table were collected from Mode S channel A. The CPU utilization percentage was measured above 80 percent in CPU DP_2 when 150 or more TIS targets were loaded.

The addition of four new TIS Performance Monitoring LU Data Points was verified and found to be operational on the 68040 DPS configuration with the maximum count was 32767. The data point counters became negative after reaching 32767.

4.3.3.6 Conclusions.
To limit the CPU to 80 percent utilization, the maximum number of TIS clients was set to 100 for 68020 hardware platform and 150 for 68040 hardware platform. There was a limited ceiling of TIS clients allowed as determined by the SAP (Req: 39.0, 40.0).

Since the SAP limited the number of current clients, the "Current Number of TIS clients" and "Current Number of TIS Alert Messages" were reflected in the display. But, if the sensor continues executing for a long period of time (days or weeks) without reset, the "Total Number of TIS Clients" and "Total Number of TIS Alerts" will become negative after reaching 32767.

4.3.4 Test Case #9: Non-Terra Mode.

4.3.4.1 Test Objective.

The objective of this test was to establish the non-Terra mode baseline of the TIS P^2I enhancement under nominal Mode S system conditions for a representative Mode S terminal configuration.

4.3.4.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 4.3.4.2-1.

TABLE 4.3.4.2-1. TEST CASE #9 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Release (SAE020T-ARIES and SAR214K-ARIES) w/Terra Mode Disabled	NONPERF1 NON200	NONPERF1.DE	2, 5-6, 9-12, 78-79, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

4.3.4.3 Data Collection and Analysis Method.

The RBAT TIS Analysis tool was used to obtain a summary/listing of TIS alerts.

4.3.4.4 Results and Discussion for 68020 DPS Configuration.

Result 1:

The following results were obtained from analysis output file NONPERF1.001, which was generated from the TIS Analysis tool for the data of file NONPERF1.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa060	0		0		0		0	
2	faa100	0		0		6	100.0	6	0.0
3	faa200	0		0		6	100.0	6	0.0
4	faa005	35	100.0	35	0.0	92	100.0	92	0.0
5	faa006	35	100.0	35	0.0	92	100.0	92	0.0
6	faa004	1	100.0	1	0.0	40	100.0	40	0.0
7	faa003	1	100.0	1	0.0	38	100.0	38	0.0
8	faa002	0		0		0		0	
9	faa001	0		0		0		0	
10	faa010	49	100.0	49	0.0	26	100.0	26	0.0
11	faa030	0		0		14	100.0	14	0.0
12	faa020	0		0		15	100.0	15	0.0
13	faa050	13	100.0	13	0.0	230	100.0	230	0.0
14	faa040	13	100.0	13	0.0	226	100.0	226	0.0
15	faa070	0		0		0		0	
16	faa007	49	100.0	49	0.0	26	100.0	26	0.0
17	faa020	0		0		17	100.0	17	0.0
18	faa030	0		0		16	100.0	16	0.0
19	faa001	0		0		0		0	
20	faa001	0		0		0		0	
TOTAL		196	100.0	196	0.0	844	100.0	844	0.0

```
Number of antenna updates = 659
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 0
```

Discussion 1:

The above results were used as a comparison to the P2I test results (as shown in Result 1 under sections 4.2.3.4).

Result 2:
The following results were obtained from analysis output file NONPERF1.002, which was generated from the TIS Analysis tool for the data of file NONPERF1.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	ATyp	Bear	Range	RelAlt
17:11:12.820	20.2	192.9	6000	160.1	165.0	faa006	344	N	T	faa005	343	TIS	33.0	1.8	550
										faa005	343	PROG	22.9	1.7	453
17:11:17.430	20.5	192.5	6000	160.1	159.0	faa006	344	N	T	faa005	343	TIS	15.0	1.5	550

Discussion 2:
As shown in the above results, Mode S track (FAA005) was sent to the alert determination process. When Terra mode was disabled, both Mode S and ATCRBS tracks were sent to the alert determination process.

4.3.4.5 Results and Discussion for 68040 DPS Configuration.

Result 1:
The following results were obtained from analysis output file NONPERF1.001, which was generated from the TIS Analysis tool for the data of file NONPERF1.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa005	35	100.0	35	0.0	93	100.0	93	0.0
2	faa006	35	100.0	35	0.0	93	100.0	93	0.0
3	faa004	1	100.0	1	0.0	43	100.0	43	0.0
5	faa100	0		0		5	100.0	5	0.0
6	faa200	0		0		6	100.0	6	0.0
7	faa003	1	100.0	1	0.0	39	100.0	39	0.0
8	faa002	0		0		0		0	
9	faa001	0		0		0		0	
10	faa010	49	100.0	49	0.0	27	100.0	27	0.0
11	faa030	0		0		14	100.0	14	0.0
12	faa020	0		0		15	100.0	15	0.0
13	faa050	12	100.0	12	0.0	227	100.0	227	0.0
14	faa040	12	100.0	12	0.0	225	100.0	225	0.0
15	faa007	49	100.0	49	0.0	27	100.0	27	0.0
16	faa020	0		0		17	100.0	17	0.0
17	faa030	0		0		16	100.0	16	0.0
18	faa070	0		0		0		0	
19	faa001	0		0		0		0	
20	faa001	0		0		0		0	
TOTAL		194	100.0	194	0.0	847	100.0	847	0.0

```
Number of antenna updates = 658
Number uncorrelated TIS advisory messages = 0
Number uncorrelated advisory messages = 0
```

Discussion 1:
The above results were used as a comparison to the P2I test results (as shown in Result 1 under sections 4.2.3.5).

Result 2:

The following results were obtained from analysis output file NONPERF1.002, which was generated from the TIS Analysis tool for the data of file NONPERF1.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
15:29:59.398	20.1	193.2	6000	159.9	165.0	faa006	87	N	T	faa005	86	TIS	21.0	1.8	550
										faa005	86	PROG	20.2	1.9	449
15:30:04.000	20.3	192.8	6000	159.7	165.0	faa006	87	N	T	faa005	86	TIS	21.0	1.5	550
										faa005	86	PROG	20.4	1.6	456

Discussion 2:
As shown in the above results, Mode S track (FAA005) was sent to the alert determination process. When Terra mode was disabled, both Mode S and ATCRBS tracks were sent to the alert determination process.

4.3.4.6 Conclusions.

As shown in results of the above two sections for both hardware platforms and builds, the following requirement was verified:

Req: 201.0 - When Terra mode was disabled (not in effect), both ATCRBS and Mode S tracks were sent to the alert determination process. See Result 2 under both sections above.

4.3.5 Test Case #10: Live Flight End-to-End Operation.

4.3.5.1 Test Objective.

The primary focus of this test case was to verify that the TIS P^2I enhancement software functioned correctly in the full-up operational environment by using live, TIS-equipped, aircraft to exercise the software. The objective of this test was to reinforce the "simulated" results obtained in sections 4.2.2 (Terra Processing and TIS Coverage Volume), 4.2.3 (TIS Self-Alert Rate Reduction and TIS Performance), and 4.2.4 (Elimination of CPME as Intruder). Also, this test was performed to verify that the transponder Mode S Extended Capability Register (GICB register 16) was read out during Mode S track acquisition when the TIS flag was enabled by SAP control.

4.3.5.2 Test Description.

This test was conducted at the Technical Center, Mode S sensor #1 (building 270) using a live, TIS-equipped aircraft as a TIS client (Mode S ID: A57534) and a fixed ground transponder as an intruder (ATCRBS ID: 0137). The aircraft flew in accordance with the flight patterns as shown in appendix D.

This test was conducted by running Mode S sensor and collecting DEs as configured in table 4.3.5.2-1.

TABLE 4.3.5.2-1. TEST CASE #10 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Release (SAE020T) w/Terra Mode Enabled	Live Flight #1 (FLY01)	FLY01.DE FLY02.DE	2, 5-6, 9-12, 19-26, 29-46, 49, 78-83, and 89- 92

* NOTE: see appendix D for flight pattern descriptions and appendix C for DE definitions

4.3.5.3 Data Collection and Analysis Method.

The RBAT TIS Analysis, Surveillance Print, and Miscellaneous Print tools were used to obtain: a summary of TIS alerts; a target listing of TIS aircraft which contains time, range, azimuth, altitude, identification codes, and track numbers; and a target listing of TIS alerts generated for uplink to the client.

4.3.5.4 Results and Discussion for 68040 DPS Configuration.

Result 1:

The following results were obtained from analysis output file FLY02.001, which was generated from the TIS Analysis tool for the data of file FLY02.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	a57534	11	100.0	11	0.0	1489	93.7	1447	3.6
3	a57534	0		0		0		0	
4	a57534	0		0		21	100.0	21	0.0
5	a57534	0		0		6	100.0	6	0.0
6	a57534	0		0		3	100.0	3	0.0
7	a57534	5	100.0	5	0.0	66	100.0	66	0.0
8	a57534	18	100.0	18	0.0	986	94.8	935	0.0
TOTAL		34	100.0	34	0.0	2571	94.4	2478	2.1

```
Number of antenna updates = 1561
Number uncorrelated TIS advisory messages = 52
Number uncorrelated advisory messages = 145
```

Discussion 1:

There were no (0 percent) false alerts (self-alerts) found as shown in the above results (under the Traffic Advisory column FAlrm). The results show that the Terra match algorithm had performed correctly to prevent the ATCRBS "image" track of the input aircraft from generating an alert against the Mode S input track.

When the Mode S Specific Protocol (MSP) bit (bit 25 in the Ground Initiated Comm B (GICB) transponder register, register 16) was set to indicate MSP avionics support, TIS set the flag that read the contents of the transponder MSP capability register (GICB transponder register, register 16) to check whether the aircraft was requesting TIS service. The sensor had received a TIS service request from the client (A57534). Therefore, during the Mode S track acquisition, in which the TIS SAP was enabled, the contents of the transponder Mode S Extended Capability Register were read out.

Result 2:
The following results were obtained from analysis output file FLY02.002, which was generated from the Surveillance Print tool for the data of file FLY02.DE:

Time-Of-Day	Cls	A S	Mo de	Range	Azimth	OBA	F B	Trck	Mode S Id	3/A Code	Alti tude	Elev Angle	
12:34:32.641	RPT	S		15.05	284.99		F		a57534	0167	1600	0.9	#ac=0 #rc=3 fs=0
12:34:37.156	*RPT*	*A*		*15.91*	*275.34*		*F*			*0204*	*-1000*	*-0.7*	*boresight bit=0*
12:34:37.258	RPT	S		15.22	284.92		F		a57534	0167	1600	0.8	#ac=0 #rc=3 fs=0
12:34:41.773	*RPT*	*A*		*15.91*	*275.30*		*F*			*0204*	*-1000*	*-0.7*	*boresight bit=0*
12:34:41.875	RPT	S		15.39	284.85		F		a57534	0167	1500	0.8	#ac=0 #rc=3 fs=0
12:34:46.391	*RPT*	*A*		*15.91*	*275.30*		*F*			*0204*	*-1000*	*-0.7*	*boresight bit=0*
12:34:46.492	RPT	S		15.57	284.79		F		a57534	0167	1500	0.7	#ac=0 #rc=3 fs=0
12:34:51.008	*RPT*	*A*		*15.91*	*275.30*		*F*			*0204*	*-1000*	*-0.7*	*boresight bit=0*

Discussion 2:
The above results show that the CPME (0204) was within the TIS coverage volume of the TIS client (A57534). For verification of Req 194.1, see the following results (in Result 3) for the time interval between 12:34:32.641 and 12:34:46.492.

Result 3:
The following results were obtained from analysis output file FLY02.003, which was generated from the TIS Analysis tool for the data of file FLY02.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt
12:34:32.641	15.0	285.0	1600	279.2	285.0	a57534	507	N	T	0175	147	TIS	315.0	3.0	1750
										0173	466	TIS	51.0	5.0	650
										1200	314	TIS	345.0	6.0	-750
										2140	389	TIS	33.0	6.0	3250
										0204	*122*	*PROG*	*285.7*	*2.7*	*-2572*
										0175	147	PROG	314.0	2.7	1604
										0173	466	PROG	51.3	5.1	570
										1200	314	PROG	344.7	5.5	-870
										2140	389	PROG	32.9	5.8	3015
12:34:37.258	15.2	284.9	1600	278.5	285.0	a57534	507	N	T	0175	147	TIS	315.0	2.5	1750
										0173	466	TIS	57.0	5.0	650
										1200	314	TIS	345.0	5.0	-750
										2140	389	TIS	39.0	6.0	3250
										0204	*122*	*PROG*	*282.7*	*2.7*	*-2554*
										0175	147	PROG	310.1	2.7	1621
										0173	466	PROG	52.3	5.0	598
										1200	314	PROG	343.7	5.5	-823
										2140	389	PROG	35.6	5.6	3036
12:34:41.875	15.4	284.9	1500	278.2	285.0	a57534	507	N	T	0175	147	TIS	309.0	2.5	1750
										0173	466	TIS	57.0	5.0	750
										1200	314	TIS	345.0	5.0	-650
										2140	389	TIS	39.0	5.0	3250
										0204	*122*	*PROG*	*279.5*	*2.6*	*-2546*
										0175	147	PROG	306.1	2.7	1629
										0173	466	PROG	52.9	4.8	610
										2140	389	PROG	38.2	5.4	3047
										1200	314	PROG	342.5	5.4	-793
12:34:46.492	15.6	284.8	1500	277.8	285.0	a57534	507	N	T	0175	147	TIS	303.0	2.5	1750
										0173	466	TIS	57.0	5.0	850
										2140	389	TIS	45.0	5.0	3250
										1200	314	TIS	345.0	5.0	-550
										0204	*122*	*PROG*	*276.2*	*2.6*	*-2554*

									0175	147	PROG	302.4	2.8	1620	
									0173	466	PROG	53.6	4.7	597	
									2140	389	PROG	41.0	5.2	3042	
									1200	314	PROG	341.5	5.4	-785	

Discussion 3:

According to the previous result (Result 2), the CPME (0204) was within the TIS coverage area of the client (A57534), but Result 3 shows that the client (A57534) had received no TIS alert from the intruder (0204). This means that the CPME was ignored in the coarse screening process.

Result 4:

The following results were obtained from analysis output file FLY02.003, which was generated from the TIS Analysis tool for the data of file FLY02.DE:

Time-Of-Day	Range	Azmth	Alt	Head	TisHd	Mds-Id	SFN	T	M	Id	SFN	AType	Bear	Range	RelAlt	
.																
12:17:51.664	2.0	332.8	400	246.4	297.0	a57534	507	N	T	7031	634	TIS	195.0	2.1	-750	
										0172	479	TIS	87.0	5.0	950	
										1617	312	TIS	117.0	6.0	3250	
										7031	634	PROG	233.4	2.1	-793	
										0172	479	PROG	129.8	4.8	915	-
										1617	312	PROG	157.3	6.3	3131	
12:17:56.234	2.0	329.4	500	235.9	285.0	a57534	507	N	T	7031	634	TIS	201.0	2.1	-850	
										0172	479	TIS	99.0	5.0	850	
										1617	312	TIS	123.0	6.0	3250	
										7031	634	PROG	240.9	2.1	-876	
										0137	113	PROG	255.5	2.5	3425	
										0172	479	PROG	142.0	4.8	822	-
										1617	312	PROG	165.8	6.3	3042	-
12:18:00.813	2.0	325.9	600	227.2	279.0	a57534	507	N	T	7031	634	TIS	207.0	2.1	-950	
										0137	*113*	*TIS*	*219.0*	*2.5*	*3250*	
										0172	479	TIS	111.0	3.9	650	
										1617	312	TIS	129.0	6.0	3250	
										7031	634	PROG	246.5	2.1	-930	
										0137	113	PROG	261.4	2.5	3371	
										0172	479	PROG	152.1	4.7	751	-
										1617	312	PROG	172.4	6.2	2971	-
.																
.																
.																
12:22:21.078	2.4	102.2	3800	302.3	327.0	a57534	507	N	T	0137	113	TIS	327.0	1.3	-2750	
										0137	113	PROG	348.6	1.4	-2875	
12:22:25.688	2.3	101.3	3900	300.6	321.0	a57534	507	N	T	0137	113	TIS	333.0	1.3	-2750	
										0137	113	PROG	349.6	1.2	-2944	
12:22:30.289	*2.2*	*100.1*	*3900*	*300.6*	*315.0*	*a57534*	*507*	*N*	*T*	*0137*	*113*	*TIS*	*339.0*	*1.3*	*-2750*	
12:22:34.883	2.1	99.1	4000	300.7		a57534	507	N	T	0137	113	PROG	347.7	1.0	-3043	
.																
.																
.																
13:19:32.828	6.9	279.1	2100	91.5	99.0	a57534	597	N	T	1200	296	TIS	195.0	6.0	-1250	
										1200	296	PROG	197.7	6.3	-1227	
13:19:37.453	6.7	279.2	2100	90.3	99.0	a57534	597	N	T	1200	296	TIS	195.0	6.8	-1250	
										1200	296	PROG	199.3	6.6	-1271	
										0106	529	PROG	2.4	6.9	-2459	
13:19:42.070	6.5	279.6	2200	89.2	99.0	a57534	597	N	T	1200	296	TIS	201.0	6.8	-1250	
										0106	529	TIS	357.0	6.0	-2750	
										0137	*113*	*TIS*	*9.0*	*6.8*	*2750*	

								0106	529	PROG	3.5	6.7	-2476
								1200	296	PROG	200.8	6.9	-1289
13:19:46.688	6.3	279.9	2300	88.1	99.0	a57534	597 N T	0106	529	TIS	357.0	6.0	-2750
								0137	113	TIS	9.0	6.8	2750
								1200	296	TIS	201.0	7.3	-1250
								0106	529	PROG	4.7	6.5	-2488
								0137	113	PROG	11.1	6.6	2813
13:19:51.305	6.1	280.2	2200	87.0	93.0	a57534	597 N T	0106	529	TIS	3.0	6.0	-2250
								0137	*113*	*TIS*	*9.0*	*6.0*	*2750*
								0106	529	PROG	5.8	6.2	-2493
								0137	113	PROG	12.5	6.4	2808

Discussion 4:

As shown in the above results, the TIS alert was sent to the client when the intruder (0137 - fixed transponder) was at 2750 feet below the client and 1.3 nmi (horizontally) away from the client (occurred at 12:22:30.289). The TIS alert was sent to the client when the intruder (0137 - fixed transponder) was at 3250 feet above the client and 2.5 nmi (horizontally) away from the client (occurred at 12:18:00.813). The TIS alert was sent to the client when the intruder (0137 - fixed transponder) was at 6.8 nmi (horizontally) away from the client and 2750 feet above the client (occurred at 13:19:42.070). According to the above results, the TIS coverage volume was successfully increased to 7 nmi range and +3500/-3000-foot altitude.

Result 5:

The following results were obtained from analysis output file FLY02.004, which was generated from the Miscellaneous Print tool for the data of file FLY02.DE:

```
13:41:39.328 scan=146 type=91 TIS Alert
13:41:39.320 mdsid=a57534 sfn=597 #alerts=3 #msgs=2 bye=F
header=2 msg_type=58 block[ 0] =c5f7e block[ 1] =cdf7e
header=2 own ac heading=351
intruder 1: sfn=329 tau_h=-186 tau_v=-9999 bearing=147 rng=3.8750 alt=  -2250 alt_rate=     Level
heading=337.5 Proximate
intruder 2: sfn=526 tau_h=-168 tau_v=-9999 bearing=153 rng=3.8750 alt=  -2250 alt_rate=     Level
heading=337.5 Proximate
header=2 msg_type=61 block[ 0] =fe5f2 block[ 1] =1f8000
intruder 3: sfn=339 tau_h=-272 tau_v=-9999 bearing=189 rng=5.0000 alt=   -650 alt_rate=     Level
heading= 67.5 Proximate

13:41:43.930 scan=147 type=91 TIS Alert
13:41:43.922 mdsid=a57534 sfn=597 #alerts=3 #msgs=2 bye=F
header=2 msg_type=0 block[ 0] =bdf7e block[ 1] =c5f7e
header=2 own ac heading=3
intruder 1: sfn=329 tau_h=-342 tau_v=-9999 bearing=141 rng=3.8750 alt=  -2250 alt_rate=     Level
heading=337.5 Proximate
intruder 2: sfn=526 tau_h=-190 tau_v=-9999 bearing=147 rng=3.8750 alt=  -2250 alt_rate=     Level
heading=337.5 Proximate
header=2 msg_type=61 block[ 0] =ee632 block[ 1] =1f8000
intruder 3: sfn=339 tau_h=-262 tau_v=-9999 bearing=177 rng=5.0000 alt=   -750 alt_rate=     Level
heading= 67.5 Proximate
```

Discussion 5:

The above result shows that the own-aircraft ground track angle was in the range of 0-59° and was quantized in 6° increments. The "ac heading=3" means the own-aircraft ground track angle was set to 0° when the TIS client aircraft heading was very near due north.

4.3.5.5 Conclusions.

As shown in results of the above section, the following requirements were verified:

Req: 194.1 - All CPMEs found were ignored in the coarse screening process. See Result 3 under the above section.

Req: 230.1 - The TIS coverage volume was increased to +3500/-3000-foot altitude and 7 nmi range. See Result 4 under the above section.

Req: 308.0 - The TIS-equipped sensor (in which TIS was SAP enabled) had read out the content of the transponder, register 16, during the Mode S track acquisition. See Result 1 under the above section.

The pre-existing software bug that caused TIS uplinks to be ignored was corrected by setting the Own Heading (OH) to 0° when the TIS client aircraft heading was very near due north. See Result 5 under the above section.

Also, false alerts (self-alerts) were completely (100 percent) eliminated for the entire flight. See Result 1 under the above section.

5. SUMMARY OF CONCLUSIONS.

After completion of the Formal and Requalification Operational Testing, the Traffic Information Service (TIS) Planned Product Improvement (P^2I) enhancements performed in accordance with TIS P^2I specification requirements with results as good or superior to the current fielded TIS/Mode S version (SAE020C/SAR214J). With the TIS P^2I enhancements present and operational on both hardware platforms and builds, the following known deficiencies that existed on the current fielded TIS/Mode Select (Mode S) version have been resolved as follows:

a. Reduction in rate of TIS self-alert generation,
b. Elimination of Mode S Calibration Precision Monitoring Equipment (CPME) targets as candidates for uplink as proximate or threat aircraft,
c. Removal of a pre-existing bug that caused TIS uplinks to be ignored when the TIS client aircraft heading is very near due north,
d. Increase in TIS alert coverage volume from 5 nautical miles (nmi) range and ±1200-foot altitude to 7 nmi range and +3500/-3000-foot altitude (expanded hockey puck),
e. Elimination of the problem that sensor ID 9 caused TIS service to be disabled,
f. Elimination of the problem that caused sensor yellow condition.

The Terra checking functions performed successfully according to the TIS P^2I specification. The TIS P^2I enhancements had no adverse effects on the general TIS performance and Mode S sensor operation.

The addition of the four new TIS Performance Monitoring Logical Unit (LU) data points (Current number of TIS clients, TIS Clients high-water mark, Current number of TIS alert messages, and TIS alert messages high-water mark) was not verified successfully. A data store size error on the Local Terminal caused the values to be displayed as negative when they reached a value of 32,767, with no other observable side effects.

Additionally, the Requalification testing demonstrated the TIS performance gains that would be realized when the Terra fix is finally removed from the Mode S software baseline. The "Maximum number of TIS Clients" could be raised significantly when the Terra fix is removed, but an upper limit was not determined at this time.

6. RECOMMENDATIONS.

After completion of the Formal and Requalification Operational Testing (OT), detailed analysis, and evaluation of Traffic Information Service (TIS) Planned Product Improvement (P^2I), ACT-310 recommends that TIS P^2I be conditionally approved for national deployment contingent upon the following:

a. All Operational Testing (OT) issues listed in OT Issues Matrix (see section 6.1) with the high criticality must be correctly implemented and successfully retested with data analysis and the test results in accordance with specification requirements. See section 7.0 (Addendum) for the results of the OT Issues Matrix Regression Testing.

b. The Aeronautical Information Manual (AIM) and all other applicable user documentation must be revised to thoroughly document the tracking limitations ("crossover problem") and potential self-alerts for TIS clients.

c. This version of TIS is only certified for fielding in a terminal sensor configuration.

d. When fielded, the "TIS Maximum Aircraft Supported" Site Adaptation Parameter (SAP) be set to the value of 100 targets (or less) for the 68020 hardware platform, and 150 targets (or less) for the 68040 hardware platform.

e. TIS Performance Monitoring Logical Unit (LU) data points be added to the 68020 baseline and the display problems on the Local Maintenance Terminal (LMT) (going negative at 32,767) be corrected.

f. Successful completion of System Testing at the Technical Center and at Key-Site by AOS is required.

6.1 OT ISSUES MATRIX.

The following table (table 6.1-1) contains outstanding OT Test anomalies, unresolved questions, and the proposed solutions or final recommendations as determined by the ACT-310 Test Team. See the TVRTM (appendix A) for the full requirements dispositions.

TABLE 6.1-1. OT ISSUES MATRIX

Req Number/ Issue Occurred	Criticality	Description of Issues	Proposed Solution
Req 129.1/ Test Case #2	**Low**	There is no reference to this algorithm in the TIS Tracking code, only in the TIS Processing code. The part of the TIS Track File that contains these fields is only used in the TIS Processing Task.	Requirement needs to be rewritten.
Req 211.3/ Test Case #2	**High**	The ground speed check portion of this algorithm has not been implemented correctly.	Corrected and successfully verified during the RQ Test Case #12 & #11
Req 224.7/ Test Case #2	**Low**	There is no variable "atcrbs_ref" used in the code as called for in the requirement, but the code meets the requirement intent.	Delete the variable "atcrbs_ref" in the requirement.
OT Issue #1	**Low**	Self-alerts were generated to some TIS clients, which had nondiscrete aircraft ID (Mode A code).	Corrected and successfully verified during the RQ Test Case #11
OT Issue #2/ Test Case #14	**Medium**	TIS tracking inaccuracy. The intruder was displayed on the wrong side of the client.	The Aeronautical Information Manual (AIM) and all other applicable user documentation must document this phenomenon.
OT Issue #3/ Existing Problem (Nov 99 Test)	**High**	No TIS alert was generated when Sensor ID was set to 9.	Corrected and successfully verified during the RQ Test Case #13
OT Issue #4/ Existing problem (field reported)	**Low**	TIS CPME Altitude overflow causes sensor yellow condition	Corrected and successfully verified during the RQ Test Case #12

Criticality: Low - Minimum risk or impact that can be fixed in a routine manner
Medium - Significant risk but can be worked around on a temporary basis
High - Mission critical risk must be fixed prior to deployment

7. ADDENDUM - OT ISSUES MATRIX REQUALIFICATION TESTING.

7.1 INTRODUCTION.

During the course of the formal OT of the TIS P^2I software several requirements were not successfully verified and some known problems were observed. This addendum addresses a Requalification OT to verify corrections to three outstanding problems discovered during the formal OT, as well as two previously known problems. It provides the detailed analysis, results, and conclusions from additional tests as a result of the corrections to these outstanding problems. The primary focus of these additional tests was to validate the corrections made to outstanding problems, which were identified in the OT Issues Matrix (see section 6.1) as opened issues, to ensure that all the TIS P^2I software enhancements have met the specification requirements.

Specifically, these corrections addressed the following problems:

a. Ground speed checks for nondiscrete aircraft IDs
b. Site ID 9 disables TIS Service
c. TIS CPME Altitude overflow causes sensor yellow condition
d. Invalid Alert Count Reporting

Additionally, the Requalification testing demonstrated the TIS performance gains that would be realized when the Terra fix is finally removed from the Mode S software baseline by rerunning the CPU Utilization and Max TIS Clients test cases with the Terra processing disabled.

7.2 TEST SYSTEM CONFIGURATION.

7.2.1 Hardware Configuration.

The hardware configuration during this Requalification testing consisted of the same 68040 hardware used during the formal OT. Testing on the 68020 hardware platform was not conducted due to the limited scope of the software modifications and unavailability of the Mode S Sensor in 68020 hardware configuration.

7.2.2 Software Configuration.

The software configuration consisted of a new SCM software image release version, SAT002, which is the version that will be fielded once testing has been successfully completed. The SAT002 release contained software modifications (for the problems identified above) built on the previous TIS P^2I software enhancements (SAE020T).

7.3 REQUALIFICATION TEST DESCRIPTION.

The Requalification (regression) OT was conducted at the Technical Center by the Surveillance Branch, ACT-310, from December 18 through 22, 2000. All tests were conducted on Mode S Sensor # 1, located in building 270.

Due to the very limited scope of the corrections and the localized and minimal software changes to implement them (most were one line changes), a very extensive Requalification test was not

deemed necessary. Verification of the corrections were logically grouped and split into five test cases. Each test case used either Test Scenarios and/or Software Code Inspection to verify the corrections.

7.3.1 Test Case #11: Ground Speed Check for Nondiscrete Targets.

7.3.1.1 Test Objective.

The objective of this test was to verify that the self-alerts to TIS clients, which have nondiscrete aircraft IDs, were eliminated or reduced after the ground speed check in the code was correctly implemented.

7.3.1.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 7.3.1.2-1.

TABLE 7.3.1.2-1. TEST CASE #11 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Releases (SAT002-ARIES w/Terra Mode Enabled	TISPERF3	TISPERF3.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

7.3.1.3 Data Collection and Analysis Method.

The RBAT TIS Analysis tool was used to obtain a summary/listing of TIS alerts.

7.3.1.4 Results and Discussion for 68040 DPS Configuration.

Result 1:

The following results were obtained from analysis output file TISPER3.001, which was generated from the TIS Analysis tool for the data of file TISPERF3.DE:

	Mode S	----Traffic Advisory---				---Proximity Advisory--			
Client	Id	Size	Rel	Size	FAlrm	Size	Rel	Size	FAlrm
1	faa004	6	50.0	3	0.0	42	97.6	42	2.4
2	faa060	4	0.0	0		2	0.0	0	
3	faa100	2	0.0	0		5	100.0	5	0.0
4	faa200	10	0.0	0		5	80.0	4	0.0
5	faa005	34	100.0	34	0.0	92	100.0	92	0.0
6	faa006	33	100.0	33	0.0	93	100.0	93	0.0
7	faa003	7	0.0	1	100.0	40	100.0	40	0.0
8	faa002	0		0		0		0	
9	faa050	20	35.0	7	0.0	239	98.7	236	0.0
10	faa001	0		0		0		0	
11	faa010	50	98.0	49	0.0	26	100.0	26	0.0
12	faa030	0		0		13	100.0	13	0.0
13	faa020	0		0		14	100.0	14	0.0
14	faa040	14	50.0	9	22.2	238	98.3	234	0.0
15	faa007	49	100.0	49	0.0	28	100.0	29	3.4
16	faa070	0		0		0		0	
17	faa020	0		0		17	100.0	17	0.0
18	faa030	0		0		17	100.0	17	0.0

```
    19 faa001        0            0              0            0
    20 faa001        0            0              0            0
TOTAL              229   79.5   185   1.6      871   98.7   862   0.2

Number of antenna updates = 659
Number uncorrelated TIS advisory messages = 5
Number uncorrelated advisory messages = 58
```

Discussion 1:
As shown in the above results, a total of three false alerts (self-alerts) out of 185 Traffic alerts (and 862 Proximity alerts) were generated to clients FAA003 and FAA040. These self-alerts were generated due to problems with Mode S surveillance and the test target simulator (ARIES) providing a few duplicate ATCRBS targets or target splits (some with 0 altitude).

7.3.1.5 Conclusions.

According to the test results, no self-alerts were generated to TIS clients, which have no intruders around. Self-alerts occurred only because of surveillance or ARIES problems.

7.3.2 Test Case #12: Ground Speed, CPME Altitude, and Site ID Code Inspect.

7.3.2.1 Test Objective.

The objective of this test case was to reverify the code inspection test for requirement 211.3. Also, the modifications in the code for the current field problems, "Site ID 9 disables TIS Service" and "CPME Altitude overflow causes sensor yellow condition" were verified.

7.3.2.2 Test Description.

The source code listing of the Mode S system image (SAT002) was provided for verification and was done manually by visual inspection for each of the requirements.

7.3.2.3 Data Collection and Analysis Method.

No formal data collection was required for the code inspection. Analysis consisted of visually comparing the selected software source code sequences to the algorithms in the TIS specification.

7.3.2.4 Inspection Results and Discussion.

R/N 211.3: The match of the ATCRBS against ModeS track shall be determined using the function TERRA_match() as defined in the requirements document.

Module: processing.c
Line#: 845
Discussion:. The code as implemented in self_match() logically matches the pseudo-code in the requirement document.

The following proposed solutions to outstanding problems were successfully verified:

a. The minimum altitude index was set to 0 for all sensor IDs.
b. CPME altitude was assigned as a long integer.

7.3.2.5 Conclusions.

All TIS requirements associated with this test have found to be 100 percent validated.

7.3.3 Test Case #13: TIS Coverage Map Based On Sensor ID.

7.3.3.1 Test Objective.

The objective of this test was to verify that the fix for "Site ID 9 disables TIS Service" was implemented correctly and that TIS alerts were generated to TIS clients for all values of the Sensor ID SAP (1 through 15).

7.3.3.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 7.3.3.2-1.

TABLE 7.3.3.2-1. TEST CASE #13 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Releases (SAT002-ARIES w/Terra Mode Enabled	TISPERF3	TISID1.DE TISID2.DE TISID3.DE TISID4.DE TISID5.DE ... TISID15.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

7.3.3.3 Data Collection and Analysis Method.

Data were collected for each time the Site/Sensor ID was changed on the SAP. The RBAT Miscellaneous Print tool was used to obtain a listing of TIS alerts.

7.3.3.4 Results and Discussion.

Collected data were examined using RBAT Miscellaneous Print tool and found that TIS alerts were generated to TIS clients when the Sensor ID in the SAP table was set to a value between 1 through 15.

7.3.3.5 Conclusions.

All sensor IDs between 1 to 15 in the SAP table were successfully verified.

7.3.4 Test Case #14: Tracking Inaccuracy (Crossover Problem) Test.

7.3.4.1 Test Objective.

The objective of this test was to confirm the presence of an existing problem with the turn detector in the TIS tracker (i.e., the aircraft crossover problem).

7.3.4.2 Test Description.

This test was conducted by running the Mode S sensor with ARIES scenarios and collecting DEs as configured in table 7.3.4.2-1.

TABLE 7.3.4.2-1. TEST CASE #14 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Files	DE Categories *
TIS P2I Test Releases (SAT002-ARIES w/Terra Mode Enabled	TISXOVRB	TISXOVRB.DE	2, 5,6, 9-12, and 89-92

* NOTE: see appendix B for scenario descriptions and appendix C for DE definitions

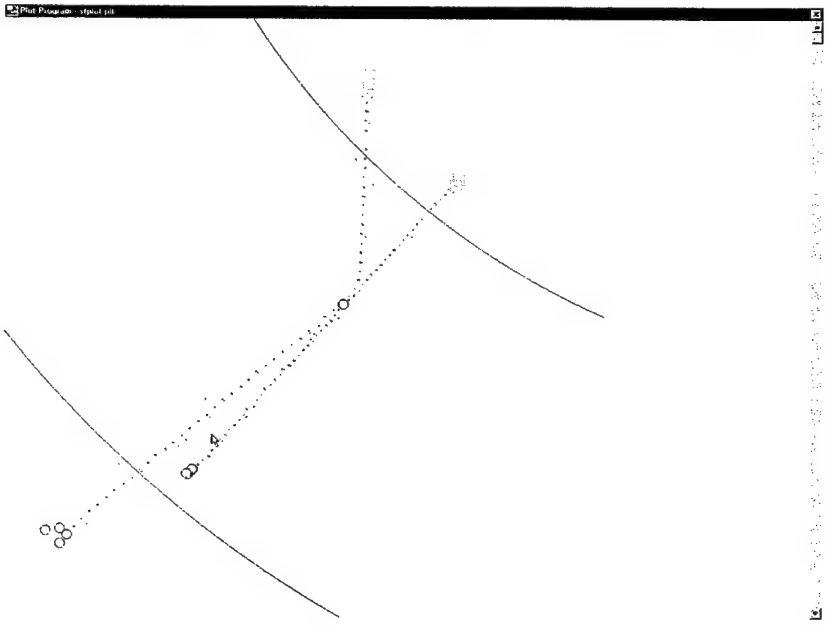
7.3.4.3 Data Collection and Analysis Method.

The RBAT Surveillance Plot and Miscellaneous Print tools were used to obtain a plot of the flight paths for both simulated targets (TIS client and intruder) and a listing of TIS alerts generated to the TIS client.

7.3.4.4 Results and Discussion.

Result 1:

The following plot result was obtained from analysis output file TISXOVRB.PLT, which was generated from the Surveillance Plot tool for the data of file TISXOVRB.DE:



Discussion 1:

According to the Mode S surveillance data, the intruder was on the right side of the client all the time. The intruder turned sharply when it came close to the client (within one-quarter mile).

Result 2:

The following results were obtained from analysis output file TISXOVRB.001, which was generated from the Miscellaneous Print tool for the data of file TISXOVRB.DE:

```
17:02:13.258 scan=47 type=91 TIS Alert
17:02:13.234 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =c8cf9 block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=11 tau_v=-1 bearing=153 rng=0.2500 alt=   -250 alt_rate=     Level
heading=202.5   Traffic

17:02:17.875 scan=48 type=91 TIS Alert
17:02:17.852 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =f0cf9 block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=10 tau_v=-1 bearing=183 rng=0.2500 alt=   -250 alt_rate=     Level
heading=202.5   Traffic

17:02:22.484 scan=49 type=91 TIS Alert
17:02:22.461 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =128cf9 block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=17 tau_v=-1 bearing=225 rng=0.2500 alt=   -250 alt_rate=     Level
heading=202.5   Traffic

17:02:27.109 scan=50 type=91 TIS Alert
17:02:27.086 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =148cf9 block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=-17 tau_v=-1 bearing=249 rng=0.2500 alt=   -250 alt_rate=     Level
heading=202.5   Traffic

17:02:31.695 scan=51 type=91 TIS Alert
17:02:31.680 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =170c7b block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=-12 tau_v=100 bearing=279 rng=0.2500 alt=    -50 alt_rate=     Level
heading=247.5   Traffic

17:02:36.336 scan=52 type=91 TIS Alert
17:02:36.305 mdsid=a63796 sfn=1 #alerts=1 #msgs=1 bye=F
header=2 msg_type=37 block[ 0] =184fb block[ 1] =1f8000
header=2 own_ac_heading=225
intruder 1: sfn=  4 tau_h=-100 tau_v=-1 bearing= 21 rng=0.0625 alt=   -250 alt_rate=     Level
heading=247.5   Traffic
```

Discussion 2:
The above results show that the intruder was on the left side of the client for four scans.

7.3.4.5 Conclusions.

As shown in Results 1 and 2 of the above section, the TIS client received four invalid alert reports indicating that the intruder was displayed on the wrong side of the TIS client.

7.3.5 Test Case #15: Non-Terra Mode CPU Utilization and Alert Count Reporting.

7.3.5.1 Test Objective.

The objectives of this test were to determine what value the "TIS Maximum Aircraft Supported" SAP should be set for field deployment, and to verify that TIS clients were limited to that

number when Terra mode was not in effect. In addition, the fix for "Invalid Alert Count Reporting" was tested as well.

7.3.5.2 Test Description.

This test was conducted by running Mode S sensor with ARIES scenario as configured in table 7.3.5.2-1.

TABLE 7.3.5.2-1. TEST CASE #15 CONFIGURATION

Sensor SW Version	Scenario(s) *	DE Categories *
TIS P2I Test Release (SAT002-ARIES) w/Terra Mode Disabled	TISMAXC	N/A

* NOTE: see appendix B for scenario descriptions.

Since ARIES channel B was not operational, this test was performed on Mode S Channel A only. At each client (TIS target) level increment, the CPU utilization percentage of channel A on the Mode S processors was recorded. The scenario continued until the sensor processors passed 80 percent utilization. The "TIS Maximum Aircraft Supported" SAP was then set to the value that kept CPU utilization under 80 percent (determined from these test runs) to verify that the number of clients were limited to that number.

7.3.5.3 Data Collection and Analysis Method.

No formal data collection was required for this test.

7.3.5.4 Results and Discussion.

When the scenario ramped up to its maximum number of TIS Clients (250), which was allowed by the LMT software, the worst CPU utilization was only 50 percent on DP_2.

7.3.5.5 Conclusions.

The worst CPU utilization was found to be 50 percent on DP_2. To adequately test this requirement (find client load at 80 percent utilization), the followings need to be developed and modified:

a. A new scenario with significantly more TIS Clients (at least 500) needs to be developed.
b. The LMT software needs to be modified to accept more TIS clients (at least 500).
c. The "TIS Maximum Aircraft Supported" SAP needs to be modified to accept more TIS clients (at least 500).

The TIS Performance Monitoring LU Data Point "Total Number of TIS Alerts" still became a negative number after reaching 32,767. Further investigation determined this is a problem on the LT and not in the TIS/Mode S sensor software.

8. ACRONYMS AND ABBREVIATIONS.

ADLP	Airborne Data Link Processor
AIM	Aeronautical Information Manual
AIN	Application Identification Number
ARIES	Aircraft Reply and Interference Environmental Simulator
ASR-9	Airport Surveillance Radar Model 9
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
CID	Communications Interface Driver
COI	Critical Operational Issues
CPME	Calibration Precision Monitoring Equipment
CPU	Central Processing Unit
DE	Data Extraction
DPS	Data Processing Subsystem
DR	Data Reduction Program
DR&A	Data Reduction and Analysis
GICB	Ground-initiated Comm B
GWS	Graphical Weather Service
IBI	Interim Beacon Interrogator
ID	Identification
LMT	Local Maintenance Terminal
LU	Logical Unit
MITLL	Massachusetts Institute of Technology Lincoln Laboratory
Mode S	Mode Select
MSIMC	Remote Maintenance Monitoring Terminal

MSL	Mean Sea Level
MSP	Mode S Specific Protocol
nmi	Nautical miles
NAS	National Airspace System
OH	Over Heading
OT	Operational Test
OT&E	Operational Test and Evaluation
PC	Personal Computer
Pd	Probability of Detection (see Blip/scan ratio)
Pfa	Probability of False Alarm
P^2I or PPI	Planned Product Improvement
P^3I or PPPI	Preplanned Product Improvement
RBAT	Radar Beacon Analysis Tool
RF	Radio Frequency
RIT	Radar Intelligence Tool
RT	Remote Terminal
RTADS	Real-Time Aircraft Display System
RU	Mode S sensor Range Unit
SAP	Site Adaptation Parameter
SCIP	Surveillance and Communication Interface Processor
SCM	System Configuration Management
SPR	System Problem Report
TCAS	Traffic Alert and Collision Avoidance System
TIS	Traffic Information Service
TSCR	TIS Connection Request
TSDR	TIS Disconnection Request

TU	Mode S sensor Time Unit
TVRTM	Test Verification Requirements Traceability Matrix
VFR	Visual Flight Rules

9. ACRONYMS AND DEFINITIONS FOR DATA REDUCTION (DR) PROGRAMS.

9.1 TIS ANALYSIS.

TIS Analysis is a program used to analyze the detection of intruders by the real-time TIS function and the reliability of the fields reported in the TIS advisory messages. Statistics are given individually for each client and combined for all the clients.

The TIS Analysis (summary) contains the following column headings:

Client : client number in decimal.
Mode S id : Mode S ID in hexadecimal.

Traffic Advisory

Size : sample size for the traffic advisory reliability.
Rel : traffic advisory reliability which is the percent of times when a traffic advisory message is determined by the TIS Analysis program that there is a correlating TIS advisory message.
Size : sample size for the traffic advisory false alarm rate.
FAlrm : traffic advisory false alarm rate which is the percent of times when there is a TIS traffic advisory message and there is no correlating advisory message determined by the TIS Analysis program.

Proximity Advisory

Size : sample size for the proximity advisory reliability.
Rel : proximity advisory reliability which is the percent of times when a proximity advisory message is determined by the TIS Analysis program that there is a correlating TIS advisory message.
Size : sample size for the proximity advisory false alarm rate.
FAlrm : proximity advisory false alarm rate which is the percent of times when there is a TIS proximity advisory message and there is no correlating advisory message determined by the TIS Analysis program.

Reliability

Size : sample size for the bearing reliability.
Bear : bearing reliability which is the percent of times the quantized bearing from the TIS advisory message is within one (6°) of the quantized bearing determined by the TIS Analysis program. Note that the bearing is not defined if the quantized range is zero in the TIS advisory message and that the sample size for the bearing reliability may differ from the reliability size given above.
Size : sample size for the range, altitude, altitude rate, heading, and status reliabilities.

Range : range reliability which is the percent of times the quantized range from the TIS advisory message is within one of the quantized range determined by the TIS Analysis program.

Alt : altitude reliability which is the percent of times the quantized relative altitude from the TIS advisory message is within one of the quantized relative altitude determined by the TIS Analysis program.

ARate : altitude rate reliability which is the percent of times the quantized altitude rate from the TIS advisory message is the same as the quantized altitude rate determined by the TIS Analysis program.

Head : heading reliability which is the percent of times the quantized heading from the TIS advisory message is within one of the quantized relative altitude determined by the TIS Analysis program.

Stat : status reliability which is the percent of times the status from the TIS advisory message is the same as the status determined by the TIS Analysis program.

The TIS Analysis (listing) contains the following column headings:

Time-Of-Day: client time-of-day in HH:MM:SS.FFF.

Range : client range in nautical miles.

Azmth : client azimuth in degrees.

Alt : client altitude in feet.

Head : client heading as computed by the TIS Analysis program in degrees.

TisHd : client heading as computed by TIS in degrees.

Mds-Id : client Mode S ID in hexadecimal.

SFN : client surveillance file number in decimal.

T : client report type (N= normal, C = coast, and D = drop).

M : client track is mature (T = true, F = false).

Id : intruder ATCRBS id in octal or Mode S id in hexadecimal.

SFN : intruder surveillance file number in decimal.

Atyp : advisory type (TIS = advisory determined by TIS, PROG = advisory determined by the TIS Analysis program).

9.2 SURVEILLANCE PRINT.

Surveillance Print is a program used to print the replies, reports, surveillance files, and disseminated reports.

The Surveillance Print contains the following column headings:

Time-Of-Day: time-of-day in HH:MM:SS.FFF. If the time between the current and the previous record is more than 1.5 antenna update periods, print an asterisk after the time-of-day.

Cls : class of the record. The possible entries are DIS (disseminated report), THR (throttled data), INT (interrogation), RIN (radar input), RPT (report), RPY

(reply), SCN (scan), SF (surveillance file), TGT (target record), and TRS (transaction record).

A/S : target type. The two possible entries are A (ATCRBS) and S (Mode S).

Mode : mode. The possible values are 1 (Mode 1), 2 (Mode 2), 3A (Mode 3/A), B (Mode B), C (Mode C), D (Mode D), 4 (Mode 4), AC (all call), RC (roll call), PR (predicted values), EA (earliest likely values), E (enroute), T (terminal), 9 (ASR9), and I0 - I3 (inhibit type). The inhibit types are I0 = time in storage, I1 = message type, I2 = replaced by beacon, and I3 = buffer full.

Range : range in nautical miles. For replies, reports, and disseminated reports this is the target range. Surveillance files are printed on three lines (two for ATCRBS) and contain the measured, predicted, and earliest likely (Mode S) range. For target records this is the earliest likely range.

Azimth : azimuth in degrees. For interrogations and replies this is the antenna azimuth. For reports and disseminated reports this is the target azimuth. Surveillance files are printed on three lines (two for ATCRBS) and contain the measured, predicted, and earliest likely (Mode S) azimuth. For target records this is the latest likely azimuth.

Oba : off boresight angle in degrees. This field is only applicable for replies and the sum of Azimuth and Oba is the target azimuth. For All Call and Roll Call replies, this field will contain a value if and only if the failure code is Valid and the monopulse estimate is between MBL and MBH. For ATCRBS replies, this field will contain a value if and only if the monopulse estimate is not zero and is between MBL and MBH.

F/B : antenna face. The two possible entries are F (front) and B (back)

Trk : surveillance file number in decimal.

Mode S Id : Mode S ID in hexadecimal. This field only applies to Mode S targets.

3/A Code : Mode 3/A code in octal. For Mode C and Mode 2 ATCRBS replies this field will be blank. For Mode S all call and roll call replies with altitude this field will be blank. For Mode S reports and surveillance files this field will be blank until the first roll call "Surveillance, Identity" or "Comm B, Identity" reply for a given target, after which it will contain the most recent Mode 3/A code.

Altitude : Mode C altitude in feet.

ElevAngle : elevation angle in degrees.

9.3 MISCELLANEOUS PRINT.

Miscellaneous Print is a program used to print miscellaneous records on the Mode S file. Some examples are performance monitoring, active message list, site adaptable data, scan data, duplicate address alert table, collimating difference table, ATCRBS radar range mask, channel configuration table, remote monitoring system messages, TIS data, and dynamic reflectors.

Each record contains a header. The header contains the extraction time of the category type, the scan number at the extraction time, the category type, and the category type name. The listing output depends on the format, which depends on the category type.

For Data Extraction (DE) type 90 (TIS Report), the Miscellaneous Print contains the followings:

rng :	Range in nautical miles
azm :	Azimuth in degrees
alt :	Altitude in feet
type :	Altitude type
gnd_rng :	ground range in nautical miles
x :	x position
y :	y position
mdsid :	Mode S ID (in hex)
aid :	ATCRBS ID (in oct)
trk :	index into track file
r_type :	report type (NORMAL, COAST, DROP)
ca :	capability
cpme :	set if CPME track (T=TRUE, F=FALSE)
mat :	set if correlation maturity bit is set
tis :	set if TIS service is requested

For Data Extraction (DE) type 91 (TIS Alert), the Miscellaneous Print contains the followings:

mdsid :	Mode S ID
sfn :	Surveillance file number
#alert :	number of intruders
#msg :	number of TIS alert messages
bye :	T = message is the Good Bye message, F = message is not the Good Bye message
tau_h :	Horizontal Tau
tau_v :	Vertical Tau
bearing :	Bearing angle
rng :	delta range
alt :	delta altitude
alt_rate :	altitude rate (level/climbing/descending)
heading :	heading angle

9.4 SURVEILLANCE FILE PLOT.

Surveillance File Plot is a program used to plot surveillance files on a Mode S file.

10. GLOSSARY.

Azimuth splits	Azimuth splits occur when beacon replies of a target are interrupted and two targets are declared
Blip/scan ratio (Probability of Detection)	The ratio of blips (the number of times a target was detected) to scans (the number of times the target should have been detected) is expressed as a percentage. The blip/scan ratio is an important figure for evaluating radar performance. For example, if the blip/scan value falls to 60 percent, the probability is greater that tracks will go into the coast mode much more frequently.
Conflict	When two or more targets are within 2 nmi and 4° of each other.
False alert	A TIS alert generated when either no aircraft is present or which is accompanied by a display of traffic in an incorrect position.
False target reports	Any discrete beacon code report determined by software analysis to be split in azimuth, split in range, or a reflected target report.
Fruit	Nonsynchronous replies, such as those caused by interrogation of the transponders by other interrogators, are called fruit.
Garble	The sensor condition where replies from different targets overlap.
Garbled replies	When two aircraft are located at approximately the same slant range and azimuth, their beacon replies can overlap. Overlapped replies that cannot be separated in time are processed as garbled replies.
Nuisance alert	A TIS alert generated because of a real aircraft, but one with which there is no danger of collision.
Range split	Range splits occur when beacon replies of a target are interrupted and two targets are declared.
Self-alert	A TIS alert generated directly on top (over) the client when no intruder aircraft is present.
Target reliability	The probability that the transponder will reply to an interrogation is called target reliability or round reliability.
Target splits	A target split occurs when one target is displayed as multiple targets.

Track swap	This is a condition where two or more targets come into close proximity (usually a conflict), and this causes a misassignment of at least one target ID for the duration of that track.

APPENDIX A

TEST VERIFICATION REQUIREMENTS TRACEABILITY MATRIX (TVRTM)

TEST VERIFICATION REQUIREMENTS TRACEABILITY MATRIX

Test Phases: BL (Baseline Tests), PI (TIS Product Improvement Tests), RG (Regression Tests), RQ (Requalification Tests)

Verification Method: CI (Code Inspection), FT (Flight Test), NT (Non-testable), SD (Scenario/Data Analysis)

Test Scenario or Live Flight: Scenario Identifier, Flight Number, or N/A (Not Applicable)

NOTE: This TVRTM is an update to the TVRTM requirements tested during the previous OT&E (July 1997) and only contains the test requirements verified in this OT. The Original requirement numbers have been maintained (i.e., xxx.0) for traceability. New requirements numbers have a non-zero digit after the decimal place (i.e., xxx.1).

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
15.1	3.2.1	Each track file entry shall contain the items described below: **Message Generation Data** Terra ATCRBS reference track - reference_track Terra ATCRBS coast count - reference_count	PI	CI	4.2.1	Yes
34.0	3.3	The following set of site-adaptable parameters (SAPs) shall control the operation of TIS processing: TIS Enable/Disable Flag TIS Maximum Aircraft Supported TIS Zenith Cone Angle TIS Magnetic Deviation Angle	RG	SD	4.3.1	Yes
36.0	3.3.1	The TIS Enable/Disable Flag SAP shall enable or disable TIS processing.	RG	SD	4.3.1	Yes
37.0	3.3.1	When TIS is disabled, a TIS-equipped sensor shall operate without TIS softtware being executed.	RG	SD	4.3.1	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
39.0	3.3.2	The TIS Maximum Aircraft Supported SAP shall control the number of aircraft requesting TIS service that may be granted service.	RG	SD	4.3.3	Yes
40.0	3.3.2	The maximum legal value for the TIS Maximum Aircraft Supported SAP shall be the maximum number of Mode S aircraft tracks allowed by the sensor.	RG	SD	4.3.3	Yes
45.1	3.3.5	The TIS Sensor Altitude SAP shall designate the altitude of the sensor antenna above sea level.	PI	CI	4.2.1	Yes
45.2	3.3.5	The TIS Sensor Altitude SAP value shall be used in the calculation of a track position's elevation angle for TERRA mode processing.	PI	CI	4.2.1	Yes
51.1	3.4.1	Other TIS track element initialization values shall be as follows: reference_track = 0 reference_count = 0	PI	CI	4.2.1	Yes
129.1	3.5.3.1	The horizontal track update to a TIS track whose horizontal track state is FIRST shall perform the following: set track "reference-track" number and "reference-track" coast count to zero	PI	CI	4.2.1	Yes
194.1	3.6.2	All CPME tracks found shall be ignored in the coarse screening process.	PI	SD, FT	4.2.4 4.3.5	Yes
200.0	3.6.2	If the TERRA mode is in effect (by SAP control), then only ATCRBS tracks shall be sent to alert determination.	RG	SD	4.3.1	Yes
201.0	3.6.2	If the TERRA mode is not in effect, both ATCRBS and Mode S tracks shall be sent to alert determination processing.	RG	SD	4.3.1	Yes
211.1	3.6.3.1	If the TERRA mode is enabled (by SAP control), then the alert determination process shall perform additional checks to prevent the ATCRBS "image" track on the input aircraft from generating an alert against the Mode S form of the input track (in order to prevent TIS "self	PI	SD	4.2.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
		alerts").				

211.2	3.6.3.1	The azimuth threshold shall be determined using function Az_thresh()" as defined in the pseudo-code below:
		
		Az_thresh(MSTRACK)
		(return suppression azimuth-match threshold)
		Alt_table[10]={14500, 14500, 14500, 14500,
		14500, 15500, 16500, 17500,
		18500, 19500}
		irange = MSTRACK.range
		(truncated to integer miles)
		IF irange > 9 THEN
		(Beyond table, return normal threshold value)
		return 0.88 degrees 40 AU
		Alt = Alt_table[irange] + sensor_alt
		IF MSTRACK.ZP > alt THEN
		return 1.32 degrees 60 AU
		ELSE
		return 0.88 degrees 40 AU
			PI	CI	4.2.1	Yes

211.3	3.6.3.1	The match of the two tracks (Mode S against ATCRBS) shall be determined using function "TERRA_match()" as defined in the pseudo-code below:
		
		TERRA_match(MSTRACK, ATRACK)
		Speed_Table[12] = {20, 40, 60, 80, 100, 120, 140, 160,
		180, 200, 220, 240}
		(Table entries in knots - sensor in RU/hour, 1977 RU / hour = 10knots)
		dr = MSTRACK.range - ATRACK.range
		IF |dr| > 0.18 nautical miles THEN
		return FALSE 36 RU
		dz = MSTRACK.ZP - ATRACK.ZP
		IF |dz| > 200 feet THEN
			PI, RQ	CI	4.2.1,
					7.3.2
						Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified

		return FALSE
		da = MSTRACK.azimuth - ATRACK.azimuth
		(allow for 0-crossing)
		athresh = Az_thresh(MSTRACK)
		IF |da| > athresh THEN
		return FALSE
		IF (MSTRACK.code not discrete) OR
		(MSTRACK.code != ATCRBS.code) THEN
		(Perform tracked velocity tests since codes don't match)
		irange = MSTRACK.range / 10
		(truncated to integer)
		IF irange > 11 irange = 11
		(limit to table 120 miles)
		vthreshold = Speed_Table[irange+1]
		dx = MSTRACK.XDE - ATCRBS.XDE
		dy = MSTRACK.YDE - ATCRBS.YDE
		IF |dx| <= vthreshold AND |dy| <= vthreshold
		THEN return TRUE
		(Perform ground-speed test now)
		ds = MSTRACK.speed - ATCRBS.speed
		IF |ds| > 10 knots THEN
		return FALSE
		(Perform heading test now)
		h1 = atan2(MSTRACK.XDE,MSTRACK.YDE)
		h2 = atan2(ATCRBS.XDE,ATCRBS.YDE)
		dh = h1 - h2
		(allow for zero crossing)
		IF |dh| > 30 degrees THEN return FALSE
		return TRUE (all matching tests passed successfully)				

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
214.1	3.6.3.1	If additional checks are to be performed, the range difference of the two tracks (Mode S against ATCRBS) shall be compared.	PI	SD	4.2.2	Yes
214.2	3.6.3.1	If range comparison is to be performed and absolute value of the range difference between the two tracks (Mode S and ATCRBS) exceeds its threshold (0.18 Nmi), then the match fails.	PI	SD	4.2.2	Yes
214.3	3.6.3.1	If TERRA checking should continue, an azimuth comparison shall also be performed.	PI	SD	4.2.2	Yes
215.1	3.6.3.1	If azimuth comparison is to be performed and absolute value of the azimuth difference between the two tracks (Mode S and ATCRBS) exceeds its threshold, then the match fails.	PI	SD	4.2.2	Yes
216.1	3.6.3.1	If TERRA checking should continue, an altitude comparison shall also be performed.	PI	SD	4.2.2	Yes
217.1	3.6.3.1	If altitude comparison is to be performed and absolute value of the altitude difference between the tracks (Mode S and ATCRBS) is too large (greater than 200ft), then these tracks shall not be considered potential duplicates.	PI	SD	4.2.2	Yes
218.1	3.6.3.1	If either track lacks a clear altitude, then the altitude difference between the tracks (Mode S and ATCRBS) shall be assumed to be zero.	PI	SD	4.2.2	Yes
219.1	3.6.3.1	If the tracks are sufficiently close in range, azimuth and altitude, further comparison shall be performed on Mode A code.	PI	SD	4.2.2	Yes
220.1	3.6.3.1	If further TERRA checks are to be performed, and if the input TIS track has a discrete ATCRBS Mode A code and it matches the ATCRBS Mode A code of the potential alert track, then the potential alert track shall be declared a TERRA match with the input TIS track.	PI	SD	4.2.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
222.1	3.6.3.1	If further TERRA checks are to be performed, and if the Mode A codes do not match or if the input TIS track did not have a discrete Mode A code (possible in cases of garble or transitioning codes), further checks shall be performed on velocity.	PI,RQ	SD	4.2.3, 7.3.1	Yes
223.1	3.6.3.1	If further TERRA checks are to be performed, the absolute values of the x and y-direction velocity differences between the two tracks (Mode S against ATCRBS) shall be calculated.	PI,RQ	SD	4.2.3, 7.3.1	Yes
223.2	3.6.3.1	If TERRA velocity checks are to be performed, and if both the x and y Cartesian absolute velocity differences are within the appropriate threshold, then the potential alert track shall be declared a TERRA match with the input TIS track.	PI,RQ	SD	4.2.3, 7.3.1	Yes
224.1	3.6.3.1	If TERRA velocity checks are to be performed and either of the Cartesian absolute velocities exceeds the threshold, then a comparison of the tracks' ground-speed shall be performed.	PI	CI	4.2.1	Yes
224.2	3.6.3.1	If ground-speed comparison is to be performed and the absolute difference between the ground-speeds of the tracks is greater than 10 knots (indicating that these tracks are not likely to be the same aircraft), then the TERRA matching test shall be declared a failure.	PI	CI	4.2.1	Yes
224.3	3.6.3.1	If the ground-speed test passes, then a track heading comparison shall be performed.	PI	CI	4.2.1	Yes
224.4	3.6.3.1	If track-heading comparison is to be performed and the absolute difference in the track headings is less than or equal to 30 degrees, then the potential alert track shall be declared a TERRA match with the input TIS track.	PI	CI	4.2.1	Yes
224.5	3.6.3.1	If track-heading comparison is to be performed and the absolute difference in the track headings is greater than 30 degrees, then the TERRA match test shall be declared a failure.	PI	CI	4.2.1	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
224.6	3.6.3.1	A flag variable "duplicate" shall be used to indicate whether a TERRA match for the input Mode S track has been found as yet.	PI	CI	4.2.1	Yes
224.7	3.6.3.1	The variable "atcrbs_ref" shall be used to store the input Mode S track's ATCRBS "reference track".	PI	CI	4.2.1	Yes

225.1	3.6.3.1	If the TERRA match between a Mode S track and ATCRBS track was found (using TERRA_match function) on a previous scan, it is highly likely that they will match again this scan. The processing for suppression of TERRA duplicate tracks shall be performed as shown in the pseudo-code below:
		
		duplicate = FALSE (haven't found ATCRBS match yet)
		atcrbs_ref = MSTRACK.reference_track
		IF atcrbs_ref != NOTRACK THEN
		(TIS track has current cross-reference, check it here for this scan)
		IF (TERRA_match(MSTRACK, atcrbs_ref)) THEN
		(Supports current cross-referencing for TIS track)
		MSTRACK.reference_count = 0
		ELSE
		(Cross-reference failed this scan, check for coast-out)
		Increment MSTRACK.reference_count
		IF MSTRACK.reference_count > 3 THEN
		(More than 3 scans of coasting, drop this cross-reference)
		MSTRACK.reference_track = NOTRACK
		MSTRACK.reference_count = 0
		atcrbs_ref = NOTRACK
			PI	CI	4.2.1	Yes

225.2	3.6.3.1	If the input Mode S track already has a TERRA reference ATCRBS track (indicating that it found a TERRA match on a preceding scan), then a "TERRA_match" test shall be made to determine if the reference track matches on this scan as well.	PI	CI	4.2.1	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
225.3	3.6.3.1	If the input Mode S track has found TERRA matches on previous scan and on this scan, then the input Mode S track's reference coast count shall be cleared to zero. Otherwise, the reference coast count shall be incremented.	PI	CI	4.2.1	Yes
225.4		If the input Mode S track has found TERRA matches on previous scan and not on this scan, then the input Mode S track's reference coast count shall be incremented.	PI	CI	4.2.1	Yes
225.5	3.6.3.1	If more than 3 consecutive coasts have occurred, then the input Mode S track's reference shall be re-initialized and "atcrbs_ref" shall be cleared. (After 3 coasts, the reference track linkage is no longer trustworthy, so a new general search must be performed.)	PI	CI	4.2.1	Yes

225.6	3.6.3.1	If the sensor is operating in TERRA suppression mode and no TERRA suppression match has been found as yet (including the cross-referenced ATCRBS track, if any), then the TERRA logic shall do further checking for each ATCRBS track input to alert-generation as shown in the pseudo-code below:
		
		IF TERRA mode enabled AND duplicate = FALSE THEN
		(Need to perform TERRA suppression check against ATCRBS tracks)
		IF atcrbs_ref != NOTRACK THEN
		(Omit the processing of the ATCRBS reference track)
		IF atcrbs_ref = ATRACK THEN
		(TERRA suppress this track immediately)
		duplicate = TRUE
		(continue with next ATCRBS track)
		ELSE
		(Check for new TERRA suppression cross-reference with this track)
		IF TERRA_match(MSTRACK,ATRACK) THEN
		(Create new TERRA cross-reference and suppress)
		duplicate = TRUE
			PI	CI	4.2.1	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
		MSTRACK.reference_track = ATRACK MSTRACK.reference_count = 0 (Continue with next ATCRBS track)				
225.7	3.6.3.1	If the input Mode S track has a reference ("atcrbs_ref"), then only the referenced ATCRBS track shall be TERRA suppressed when it is found during the alert-generation search. (There is no need to check the match conditions here, as they have already been checked above.)	PI	CI	4.2.1	Yes
225.8	3.6.3.1	If the input Mode S track has no current reference (either the Mode S track has just been initialized, or the current reference track has coasted out), then each ATCRBS track processed during alert generation shall be checked to find the new reference track.	PI	CI	4.2.1	Yes
225.9	3.6.3.1	If the sensor is operating in TERRA suppression mode and if a new reference has been found, the "duplicate" flag shall be set TRUE to prevent further TERRA checking for this input Mode S track on the current scan.	PI	CI	4.2.1	Yes

228.0	3.6.3.2	The determination of a threat condition shall be performed as follows:
		IF (In_range(th,120 seconds)) OR (r2<1.5 Nmi**2) THEN
		horizontal OK, now check vertical direction
		IF (both tracks have clear altitude) THEN
		dvz = potential track's ZD – input TIS tracks's ZD
		IF (dvz=0) THEN tv=-1 "divide by zero"-force diverge
		ELSE
		tv = dz/dvz calculate vertical tau
		ELSE
		tv = 1 aircraft assumed converging, small tau
		IF (In_range(tv,120 seconds))OR(dalt<1200 feet) THEN
		altitudes too close already, or converging
			RG	SD	4.3.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified

		IF (In_range(th,34 seconds))OR(r2<0.5Nmi**2)
		THEN
		ranges too close already or converging
		IF (In_range(tv,34 seconds))OR(dalt<800 feet) THEN
		declare a threat condition with following notation
		In_range(x,p):=(x>0) AND (x<p)				

230.1	3.6.3.3	If the threat determination tests fails, then testing for a proximity alert shall be performed as follows: IF (dz > -3000 feet) AND (dz < 3500 feet) AND (r2 < (7 Nmi)^2) THEN declare proximity alert	PI	SD	4.2.2	Yes
232.0	3.6.4	All threat alerts shall be prioritized ahead of proximity alerts.	RG	SD	4.3.2	Yes
233.0	3.6.4	Within an alert category, alerts shall be prioritized in order of increasing range separation.	RG	SD	4.3.2	Yes
259.0	3.6.5.	TIS Traffic Alert messages shall be composed of the 8-bit MSP header, the 6-bit message type field, and two Traffic Data Blocks, as shown in the following figure: Header / Message Type / Traffic Block 1 / Traffic Block 2 8 / 6 / 21 / 21	RG	SD	4.3.2	Yes
260.0	3.6.5.1.1	A maximum of 8 traffic alerts for a given TIS-equipped aircraft shall be passed to TIS message formation processing.	RG	SD	4.3.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
262.0	3.6.5.1.1	The individual alert messages shall be grouped as indicated in the following table: Number of Traffic Aircraft — Structure of Group 1 — first 2 — first 3 — first, final 4 — first, final 5 — first, ntermediate, final 6 — first, intermediate, final 7 — first, intermediates (2), final 8 — first, intermediates (2), final	RG	SD	4.3.2	Yes
264.0	3.6.5.1.1	The first message in each group shall convey the own-aircraft ground track angle.	RG	SD	4.3.2	Yes
270.0	3.6.5.1.3	If the TIS alert message being processed is an intermediate message in the group (neither first nor final), then the message type field shall be set to the value 60.	RG	SD	4.3.2	Yes
271.0	3.6.5.1.3	If the TIS alert message being processed is the final message in the group, then the message type field shall be set to the value 61.	RG	SD	4.3.2	Yes
272.0	3.6.5.1.3	TIS keep-alive messages shall set the message type value to 63.	RG	SD	4.3.2	Yes
273.0	3.6.5.1.3	TIS goodbye messages shall set the message type value to 62.	RG	SD	4.3.2	Yes
274.0	3.6.5.1.4	Each TIS Traffic Data uplink Traffic Data message shall contain two 21-bit Traffic Information Blocks whose structure is shown in the figure below: Traffic Bearing (6) — Traffic Range (4) — Relative Altitude (5) — Altitude Rate (2) — Traffic Heading (3) — Traffic Status (1)	RG	SD	4.3.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
277.0	3.6.5.1.4	The 6-bit Traffic Bearing field shall contain the bearing angle from the own-aircraft to the alert aircraft, quantized in 6-degree increments.	RG	SD	4.3.2	Yes
279.0	3.6.5.1.4	The Traffic bearing angle shall be defined by TIS with respect to the sensor-measured own-aircraft ground track.	RG	SD	4.3.2	Yes
281.0	3.6.5.1.4	If there is only one traffic aircraft used in a given TIS message, the second Traffic Information Block in the TIS message shall not contain valid information.	RG	SD	4.3.2	Yes
282.0	3.6.5.1.4	To indicate there is only one traffic aircraft in the TIS message, the Traffic Bearing field in the unused Traffic Information Block shall be set to the value 63 (representing a bearing angle greater than 360 degrees) and the remainder of the bits in the Traffic Information Block shall be cleared to zero.	RG	SD	4.3.2	Yes
283.0	3.6.5.1.4	The 4-bit Traffic Range field shall contain the distance between the own-aircraft and the alert aircraft.	RG	SD	4.3.2	Yes
287.0	3.6.5.1.4	The 5-bit Relative Altitude field shall contain the difference in altitude between the own-aircraft and the alert aircraft.	RG	SD	4.3.2	Yes
289.0	3.6.5.1.4	The 2-bit Altitude Rate field shall indicate whether the alert aircraft is climbing (code 1), descending (code 2), or level (code 3).	RG	SD	4.3.2	Yes
290.0	3.6.5.1.4	An altitude rate of 500 feet per minute shall be used as a threshold.	RG	SD	4.3.2	Yes
292.0	3.6.5.1.4	The 3-bit Traffic Heading field shall contain the ground track angle of the alert aircraft quantized to 45-degree (i.e. compass-point) increments.	RG	SD	4.3.2	Yes
294.0	3.6.5.1.4	The 1-bit Traffic Status field shall identify the type of alert represented by the Traffic Information Block being processed, where a Status value of 0 shall indicate a "proximity" alert, while a Status value of 1 shall indicate a "traffic" alert.	RG	SD	4.3.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
295.0	3.6.5.2	TIS "keep-alive" messages shall be generated for uplink to aircraft receiving TIS support whenever any of the following conditions occur: a) the previous scan's TIS update for the selected aircraft had traffic and the current update does not (the keep-alive message causes the airborne display to be cleared) b) 60 seconds minus 1 scan interval has elapsed since the previous TIS update for the aircraft being processed (the keep-alive message causes the 60-second airborne timer for TIS support to be reset) c) the TIS-requesting aircraft has entered coverage, its TIS track entry is now mature, and there are no alert uplinks to send the current scan (the keep-alive starts the airborne display)	RG	SD	4.3.2	Yes
298.0	3.6.5.3	TIS "goodbye" messages shall be generated for uplink to aircraft receiving TIS support whenever any of the following conditions occur: a) the TIS-requesting aircraft track has moved out of TIS coverage of the sensor, b) the TIS-requesting aircraft track has moved into the sensor's TIS zenith cone, c) the sensor TIS software is re-initializing after a sensor channel switch, d) more than 2 sensor scans have elapsed since a TIS-requesting aircraft track was last updated by surveillance, either by report update or track coast.	RG	SD	4.3.2	Yes
300.0	3.6.5.3	The remaining 42 bits of a TIS good-bye message uplink are unused and shall be cleared to zero.	RG	SD	4.3.2	Yes
308.0	3.7.1	A TIS-equipped sensor in which TIS is SAP-enabled shall read out the contents of a transponder Mode S extended capability register (GICB register 16) during Mode S track acquisition.	RG	FT	4.3.5	Yes
337.0	3.8.2	Each mature track requesting service must receive either traffic data or	RG	SD	4.3.2	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
		keep-alive uplink messages at least every 60 seconds.				
355.0	2.0	The performance of the TIS sensor implementation shall be measured by comparing the displayed TIS intruder aircraft relative position (as determined from the TIS traffic uplink messages generated) against a "truth" relative intruder position.	RG	SD	4.2.3	Yes
356.0	2.0	The "truth" position shall be computed as the relative position of the intruder aircraft on the scan when the TIS traffic uplink message would be received by the TIS-equipped aircraft -- i.e. one scan later than the uplink was generated.	RG	SD	4.2.3	Yes
356.5	2.0	The "truth" proposition shall be computed using the sensor surveillance reports generated for the particular scan on which the evaluation of the TIS uplink is being conducted.	RG	SD	4.2.3	Yes
357.0	2.0	A determination of the correctness of each TIS traffic uplink message shall be made.	RG	SD	4.2.3	Yes
358.0	2.0	A TIS traffic uplink message shall be declared "correct" if each of the following conditions is met: a) relative range matches within plus or minus 1 TIS range scale level b) relative bearing matches within plus or minus 1 TIS bearing level (i.e. +/- 6 degrees) c) relative altitude matches within plus or minus 1 TIS altitude level (i.e. +/- 100 feet within +/- 1,000 foot separation) d) alert state (nothing, proximate, traffic alert) is appropriate with the TIS specification of "proximate" and "traffic" e) intruder altitude rate indicated appropriately (i.e. level if intruder level, climbing if the intruder is climbing at greater than 500 feet/minute, descending if the intruder is descending at greater than 500 feet/minute) f) TIS uplinks are consistent with the sensor surveillance reports	RG	SD	4.2.3	Yes

Req #	Spec Para	Requirement Text	Test Phase	Verif Method	Verified in Final Rpt Paragragh	Successfully Verified
		for the scan under discussion.				
359.0	2.0	A scenario run shall be declared as "passed" if 90 percent or more of the TIS traffic uplink messages are declared "correct" over the entire scenario.	RG	SD	4.2.3	Yes

APPENDIX B

SCENARIO DEFINITIONS

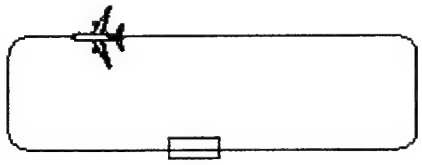
SCENARIO DEFINITIONS

Below is a description of the 13 test target scenarios that were used for Scenario-Driven Testing.

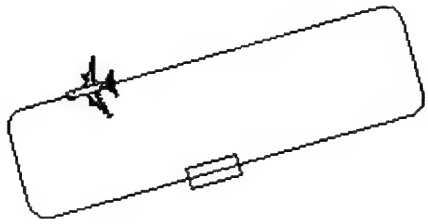
B.1 - TIS Performance #1 – (TISPERF1).

This scenario consists of all TIS clients, simultaneously flying various typical maneuvers and encounters. Some were taken from the November 99 TIS Testing and previous TIS testing. It primary intent is to simulate typical flight patterns, and ones that will cause self-alerts. This is a Terra mode scenario with the following targets spreading out in the terminal airspace:

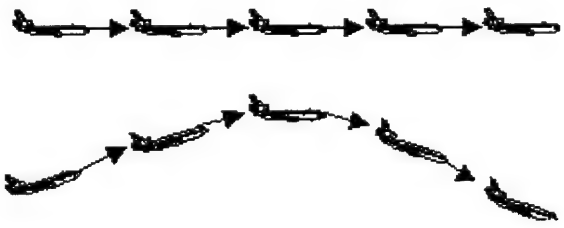
A. Missed Approaches @ ACY: one target (FAA001/ID=1200) flies a series of low approaches to the Tech Center runway in a local traffic pattern. The aircraft will fly three approaches and during each missed approach it should come within 100' of the runway.



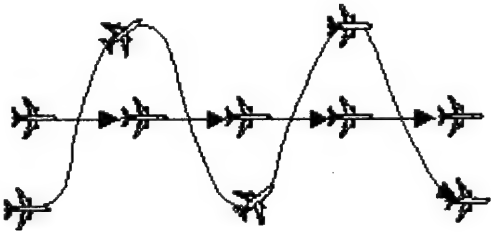
B. Missed Approaches @ MIV: one target (FAA002/ID=1201) flies a series of low approaches to the Milville Airport runway in a local traffic pattern that takes the aircraft in and out (below) of the radar coverage. The aircraft will fly three approaches and during each missed approach it should come within 100' of the runway.



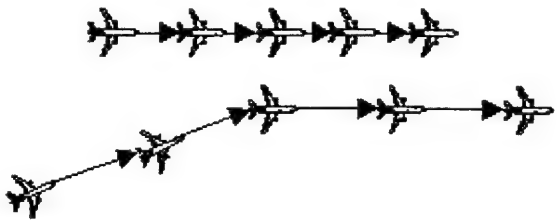
C. Vertical Maneuvering: the Intruder (FAA004/ID=0004) will fly on the same course as the Client (FAA003/ID=0003), starting at 4000 feet below the Client, with no more than one-eighth (1/8) mile horizontal separation. The Intruder will then ascended at 2000 ft per minute to within 500 feet of the Client. The Intruder will then continue on the same course as Client descending at a rate of 4000 ft per minute to an altitude of 4000 feet below Client.



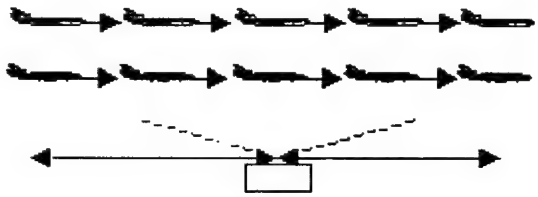
D. Horizontal Maneuvering: the Client (FAA005/ID=0005) flies a straight radial away from (or towards) the ACY sensor. The Intruder (FAA006/ID=0006) flies an S-turn pattern crossing the Client's flight path by approximately 4 nmi before turning. The Intruder flies at an altitude 500 feet below the Client.



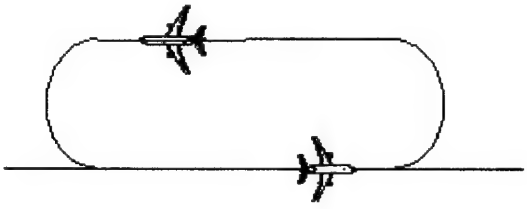
E. Merging Track: the Intruder (FAA010/ID=0010) starts from a range of 8 nmi behind and 8 nmi off the right wing of the Client (FAA0007/ID=0007). The Intruder then flies toward the Client to a range of approximately 1/4 nmi and then turns right to a path parallel to the Client. The Intruder will then fly ahead of the Client for one minute. The Intruder will fly at 500 feet below Client.



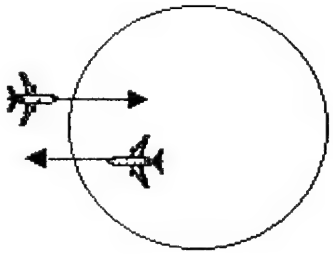
F. Zenith Cone Entry: both targets (FAA020/ID=0020 and FAA030/ID=0030) fly through the zenith cone at the ACY Mode S sensor to a range of 8 nmi past ACY. They will remain within 1 nmi horizontally and 2000' vertically of each other during the pass.



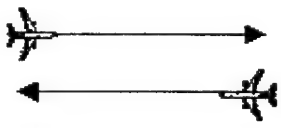
G. Stacked Holding Pattern: both targets (FAA040/ID=0040 and FAA050/ID=0050) fly a standard stacked holding pattern, with vertical separation of 1000'. Each aircraft will fly the holding pattern five times. Airspeeds will be dithered to excite a number of pattern encounters.



H. TIS Coverage Boundary: one Client (FAA060/ID=0060)) starts within coverage and flies outbound beyond 75 Nmi range. The second client (FAA070/ID=0070) starts outside the 75 Nmi range and flies inbound into coverage.



I. High Speed, Rapidly Climbing/Descending : both aircraft fly straight lined path for 4 minutes. One (FAA100/ID=0100) flies 300 knots while climbing 4000' per minute, while the other (FAA200/ID=0200) flies 500 knots while descending 5000' per minute.



B.2 - TIS Performance #2 – (TISPERF2).

This scenario will consist of 12 pairs of targets, all TIS clients, simultaneously flying various types of encounters. Some were taken from the July 1997 TIS OT&E (subset of 18 performance scenarios), and others represent high performance aircraft in various encounters. Its primary intent is to generate data to assess TIS performance accuracy. This is a Terra mode scenario that consists of the following target pairs, spread out in the terminal airspace:

A. Crossing, Climbing Encounter: The aircraft fly a Crossing pattern, while Climbing, with the client (FAA001/ID=0001) starting at (x-coordinate = -20 miles, y-coordinate = -20 miles) and flying North at start of the scenario. The intruder (FAA101/ID=1001) flies east crossing the client's flight path. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

B. Crossing, Descending Encounter: The aircraft fly a Crossing pattern, while Descending, with the client (FAA002/ID=0002) starting at (x-coordinate = 0 mile, y-coordinate = -20 miles) and flying North at start of scenario. The intruder (FAA102/ID=1002) flies east crossing the client's flight path. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

C. Crossing, Leveling Encounter: The aircraft fly a Crossing pattern, in Level flight, with the client (FAA003/ID=0003) starting at (x-coordinate = 20 miles, y-coordinate = -20 miles) and flying North at start of scenario. The intruder (FAA103/ID=1003) flies East crossing the client's flight path. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

D. Head-on, Climbing Encounter: The aircraft fly Head-On, while Climbing, with the client (FAA004/ID=0004) starting at (x-coordinate = -50 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA104/ID=1004) flies South until it has passed the client by 10 miles. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

E. Head-on, Descending Encounter: The aircraft fly Head-On, while Descending, with the client (FAA005/ID=0005) starting at (x-coordinate = -40 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA105/ID=1005) flies South until it has passed the client by 10 miles. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

F. Head-on, Level Encounter: The aircraft fly Head-On, in Level flight, with the client (FAA006/ID=0006) starting at (x-coordinate = -30 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA106/ID=1006) flies South until it has passed the client by 10 miles. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

G. Overtake, Climbing Encounter: The aircraft fly an Overtaking, while Climbing, with the client (FAA009/ID=0011) starting at (x-coordinate = 30 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA109/ID=1011) will overtake and pass the client. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

H. Overtake, Descending Encounter: The aircraft fly an Overtaking, while Descending, with the client (FAA008/ID=0010) starting at (x-coordinate = 20 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA108/ID=1010) will overtake and pass the client.

The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

I. Overtake, Level Encounter: The aircraft fly an Overtaking route, in Level flight, with the client (FAA007/ID=0007) starting at (x-coordinate = 10 miles, y-coordinate = 0 mile) and flying North at start of scenario. The intruder (FAA107/ID=1007) will overtake and pass the client. The client flies at a constant speed of 120 knots and the intruder flies at a constant speed of 150 knots.

J. High-Speed, Crossing, Climbing Encounter: The aircraft fly a Crossing pattern, while Climbing less than 500 fpm, with the client (FAA203/ID=2003) starting at (x-coordinate = -30 miles, y-coordinate = 30 miles) and flying East at start of the scenario. The intruder (FAA303/ID=3003) flies North crossing the client's flight path. The client flies at a constant speed of 240 knots and the intruder flies at a constant speed of 300 knots.

J. High-Speed, Head-on, Level Encounter: The aircraft fly Head-On, in Level flight, with the client (FAA202/ID=2002) starting at (x-coordinate = 30 miles, y-coordinate = -40 miles) from sensor and flying West at start of scenario with a constant speed of 520 knots. The intruder (FAA302/ID=3002) flies East and passes the client with a constant speed of 650 knots.

L. High-Speed, Overtake, Climbing Encounter: The aircraft fly an Overtaking, while Climbing greater than 500 fpm, with the client (FAA 201/ID=2001) starting at (x-coordinate = -50 miles, y-coordinate = -30 miles) and flying East at start of scenario. The intruder (FAA301/ID=3001) will overtake and pass the client. The client flies at a constant speed of 240 knots and the intruder flies at a constant speed of 300 knots.

B.3 - TIS Performance #3 – (TISPERF3).

This scenario is essentially identical to TISPERF1, except for the aircraft ID (mode A code). All targets have the same non-discrete mode A code, which is 1200.

B.4 - Terra Match and TIS Coverage Volume – (TERP2I).

This scenario is used for checking the Terra match algorithm and the TIS coverage volume. It consists of targets as described below:

Target 1 (FAA001/ID=0001) simulates a TIS client in Terra mode (contains two tracks, Mode S and ATCRBS). It starts at 5 Nmi range, 135 degrees azimuth, and 5000 feet altitude and flies along the 135-degree axis with a constant speed of 150 Nmi/hr. This target will fly for 10 minutes with the range difference between the two tracks (Mode S against ATCRBS) slowly increasing until it exceeds the Terra matching range threshold (0.18Nmi).

Target 2 (FAA002/ID=0002) simulates a TIS client in Terra mode (contains two tracks, Mode S and ATCRBS). It starts at 30 Nmi range, 180 degrees azimuth, and 5000 feet altitude and flies along the y-axis with a constant speed of 150 Nmi/hr. This target will fly for 10 minutes with the azimuth difference between the two tracks (Mode S against ATCRBS) slowly increasing until it exceeds the Terra matching azimuth threshold (0.88).

Target 3 (FAA003/ID=0003) simulates a TIS client in Terra mode (contains two tracks Mode S and ATCRBS). It starts at -10 Nmi (x coordinate), -30 Nmi (y coordinate), and 5000 feet altitude and flies along the y-axis with a constant speed of 150 Nmi/hr. This target will fly for 10 minutes with the altitude difference between the two tracks (Mode S against ATCRBS) slowly increasing, until it exceeds the altitude threshold (200 feet).

Target 4 (FAA004/ID=0004) simulates a TIS client (contains two tracks, Mode S and ATCRBS). It starts at -20 Nmi (x-coordinate), -30 Nmi (y-coordinate), and 5000 feet altitude and flies along the y-axis with a constant speed of 150 Nmi/hr. This target will fly for 10 minutes with unclear altitude on ATCRBS track for the first 5 minutes and unclear altitude on Mode S tracks for the last 5 minutes.

Target 5 (FAA005/ID=0005), 6 (FAA006/ID=0006), and 7 (FAA007/ID=0007) simulate 3 TIS clients (each containing two tracks, Mode S and ATCRBS). Target 6 starts at -40 Nmi (x-coordinate), -30 Nmi (y-coordinate), and 5000 feet altitude and flies along the y-axis with a constant speed of 180 Nmi/hr. Target 5 starts at -30 Nmi (x-coordinate), -30 Nmi (y-coordinate), and 4000 feet altitude and flies toward target 6 and meets target 6 at -40 Nmi (x-coordinate) and 0 Nmi (y-coordinate) after 10 minutes of flying. Target 7 starts at -45 Nmi (x-coordinate), -30 Nmi (y-coordinate), and 1000 feet altitude and flies along target 6 with a climbing rate of 1000 feet/min.

B.5 - TIS Coverage Boundaries – (TIS4411).

This scenario consists of six different targets requesting TIS service. The first target starts within coverage and flies outbound beyond 75 nmi range. The second target starts outside the 75 nmi range and flies inbound into coverage. The third target will fly through the zenith cone. The forth target starts in the center of the zenith cone and flies outbound leaving the zenith cone. The fifth target does not request TIS service until the scenario has been running for a while. The sixth target starts on the y-axis 55 nmi to the east and flies north descending to –100 ft altitude and then returning to 4000 ft. FAA001 and FA002 fly at 420 knots; FAA003 flies at 480 knots; FAA004 and FAA005 fly at 240 knots; and FAA006 flies at 120 knots.

B.6 - TIS Mixed Intruders – (TIS4422).

This scenario consists of 3 groups of 5 targets, each containing one TIS client with four intruders. The clients all fly outbound, as well as the intruders. The groups are different as far as intruder altitude and heading in relation to the client. Each group will cause a different sequence of proximate and traffic advisories.

B.7 - TIS Intruder alert priority – (TIS4423).

This scenario consists of one TIS client and eight intruders. Four of the intruders will generate proximate advisories and four of the intruders will generate traffic advisories.

B.8 - TIS Maximum Intruders – (TIS4424).

This scenario consists of one TIS client and twelve intruders. The twelve intruders will fly so as to cause twelve advisories to be generated at one time. The client aircraft flies at a constant speed of 60 Knots and the intruders fly at constant speed of 60, 62, and 120 knots.

B.9 - TIS Maximum Client/Capacity – (TISMAXC).

This scenario starts with 50 TIS client aircraft and then increases the number of TIS client's by 10 every 2 minutes until it reaches 238 TIS clients. The targets are spread out over the entire coverage area.

B.10 - TIS Non-Terra Performance #1 – (NONPERF1).

This scenario is a non-Terra version of TISPERF1. It essentially identical to TISPERF1, but there are no duplicate ATCRBS targets for Terra Mode.

B.11 - TIS Non-Terra 200 Target Wedge – (NON200).

This is a non-Terra scenario that consists of 150 ATCRBS targets and 50 TIS client aircraft. The 50 TIS clients issue requests for service during the scenario. The client aircraft fly at speeds as low as 30 knots up to 160 knots. The ATCRBS intruder aircraft fly at speeds from 35 knots up to 160 knots. All the aircraft are located in a dense pattern of approximately 125 degrees.

B.12 - CPME Simulation – (CPMEB).

This scenario contains two simulated CPMEs and two TIS clients. The TIS clients will fly over the CPMEs with an altitude of 1000 feet above the CPME.

B.13 - TIS Crossover Problem – (TISXOVRB).

This scenario consists of one TIS client and one intruder flying in a pattern, which was taken from the live-flight testing. The client will fly on a straight-level flight. The intruder will approach to the client from the right side of the client. When the intruder comes close to the client (within 1/4 mile), it will turn sharply and fly parallel to the client.

APPENDIX C

MODE S DATA EXTRACTION (DE) CATEGORIES

MODE S DATA EXTRACTION (DE) CATEGORIES

Below is a list of Mode S Data Extraction Categories and their identifying numbers used during the course of this test.

2 - Roll Call	36 - Sensor fail recov msg
5 - ATCRBS report	37 - Control state msg
6 - Mode S report	38 - Test response message
9 - CD2 terminal	39 - Status message
10 - ASR9 data	40 - Track alert message
11 - SF ATCRBS synch	41 - WCP capability req
12 - SF Mode S sync	42 - State request
19 - Standard uplink	43 - Position request
20 - ELM uplink	44 - State message
21 - Downlink request	45 - Position message
22 - ATCRBS id request	46 - Track drop message
23 - Cancel request	49 - Sensor recov notice
24 - Reject delay notice	78 - Pilot downlink
25 - Reject delay with ids	79 - Pilot downlink position
26 - Uplink deliver notice	80 - Broadcast downlink
29 - ELM downlink	81 - Broadcast downlink position
30 - ELM downlink position	82 - Ground init downlink
31 - Capability message	83 - Ground init downlink position
32 - ATCRBS id message	89 - TIS track file
33 - Test request	90 - TIS report
34 – ATC fail recovery msg	91 - TIS alert
35 – ATC capability req	92 - TIS request

APPENDIX D

LIVE FLIGHT EVENT DESCRIPTIONS

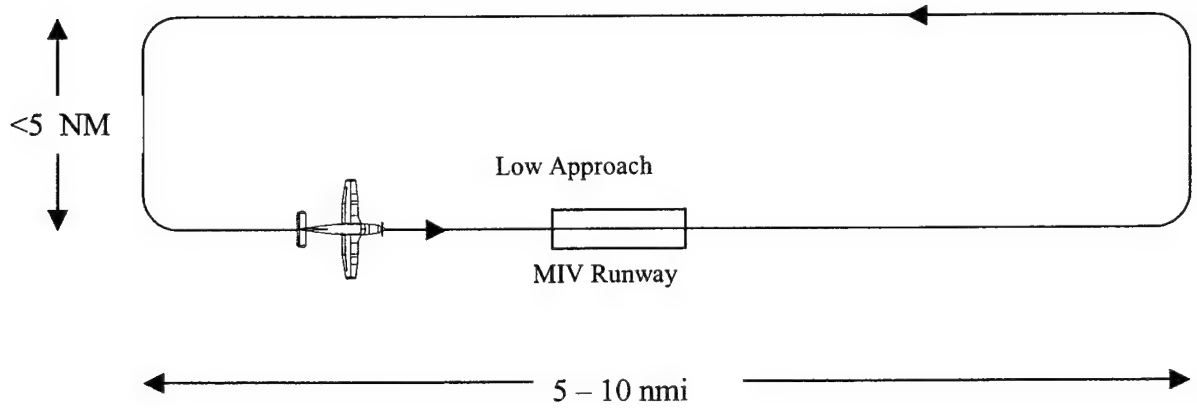
LIVE FLIGHT EVENT DESCRIPTIONS

Below is a description of the 5 flight profiles used during live flight test:

EVENT L-1:

Objective: Observe TIS self alerts and target tracking during a common aircraft maneuver at a satellite airport. Verify TIS does not uplink self-alert messages.

Plan View



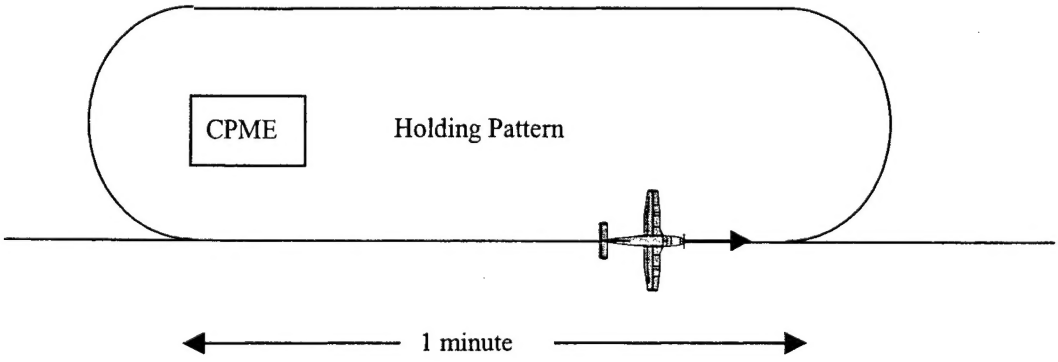
Aircraft	ID	Altitude (ft)	Speed (KIAS)
Client (C)	TBD	TBD	140

During this event the Client(C) flew a series of low approaches to the MIV runway in a local traffic pattern. Aircraft flew three approaches and during each missed approach the aircraft came within 100' of the runway

EVENT L-2:

Objective: Observe TIS does not uplink CPME as an intruder.

Plan View



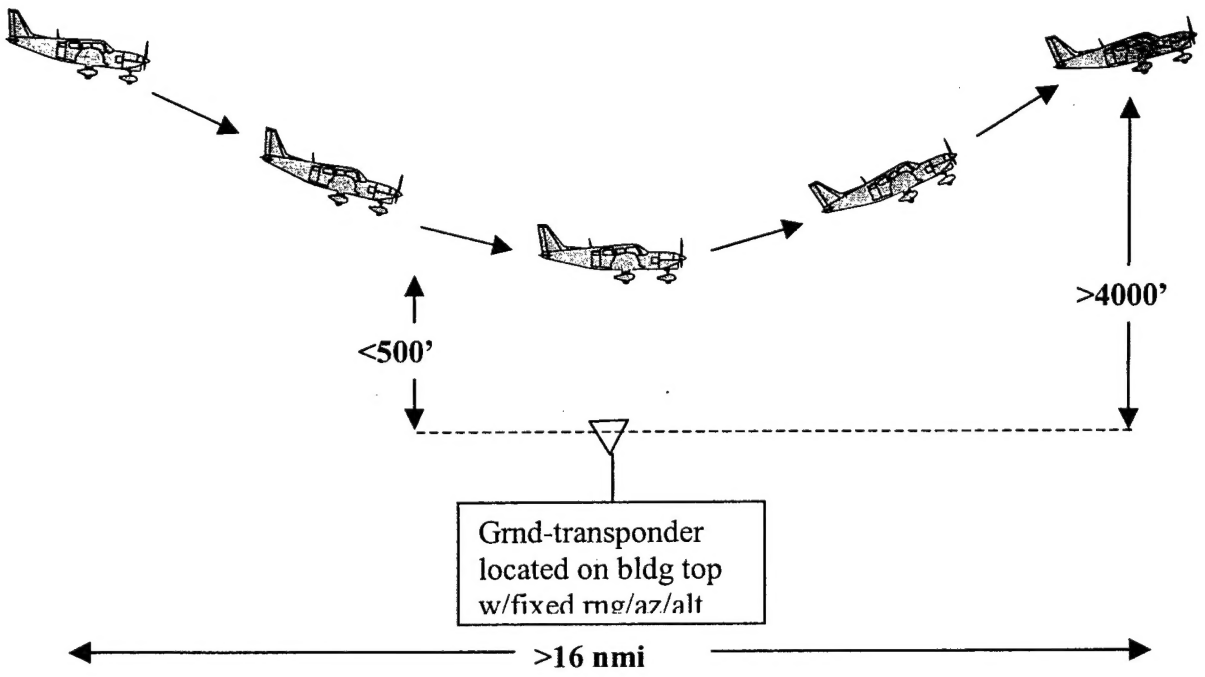
Aircraft	ID	Altitude (ft)	Speed (KIAS)	Location (rng/az)
Client (C)	TBD	1500	TBD	N/A
CPME1	0202	-900'	0	10135 RUs / 5500 AUs
CPME2	0204	-1000'	0	3147 RUs / 12526 AUs

Description: During this the TIS Client flew a standard holding pattern above one of the two Mode S CPMEs. Aircraft flew the holding pattern three (3) times around the CPME.

EVENT L-3:

Objective: Observe normal TIS volume boundary conditions and alert messages for expanded hockey puck.

Elevation View



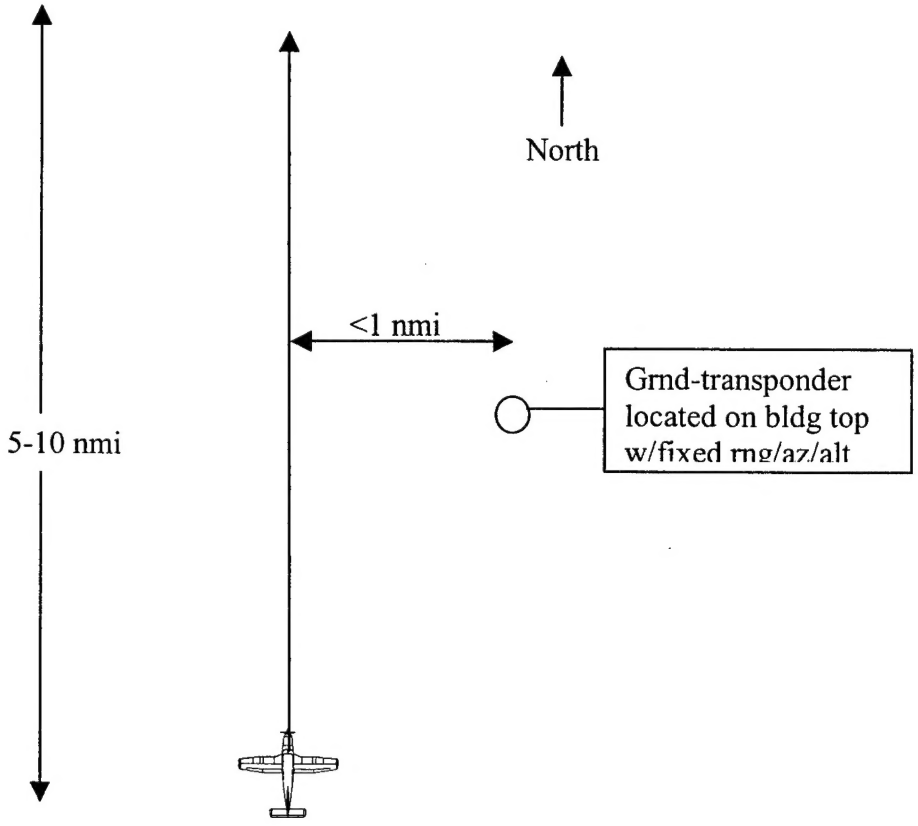
Aircraft	ID	Altitude (ft)	Speed (KIAS)	Location (rng/az)
Client (C)	TBD	TBD	140	N/A
Intruder (I)	0137 (FAA1)	3300'	0	1 NM / 91 deg (apprx)

During this event the Client (C) flew over a stationary Intruder (ground-based transponder) such that the intruder crossed all surfaces (upper, lower & sides) of the traffic proximity and alert volume boundaries (hockey puck). Client conducted horizontal as well as vertical maneuvers against the stationary Intruder such that traffic proximity and alert messages were generated.

EVENT L-4:

Objective: Observe north heading fix works properly.

Plan View



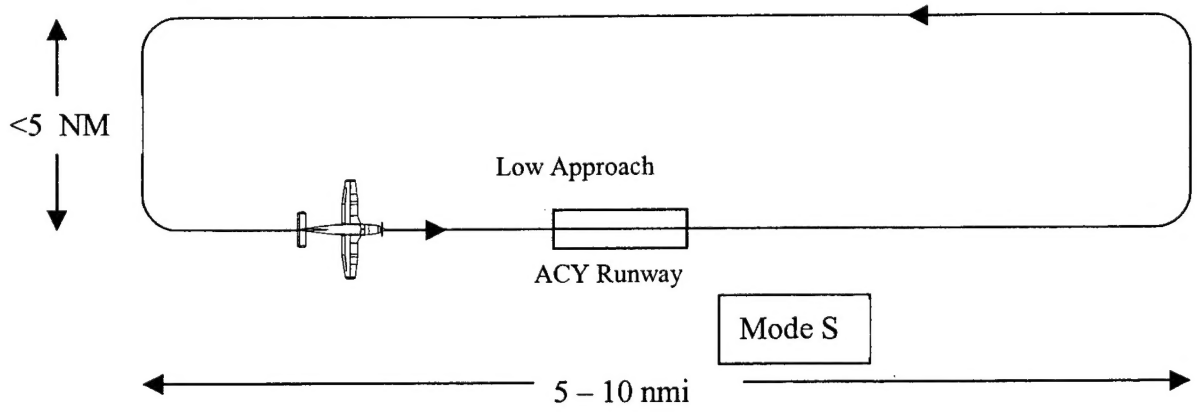
Aircraft	ID	Altitude (ft)	Speed (KIAS)	Location (rng/az)
Client (C)	TBD	TBD	140	N/A
Intruder (I)	0137 (FAA1)	3300'	0	1 NM / 91 deg (apprx)

During this event the Client(C) flew a heading, due north, within traffic proximity range of the stationary Intruder (I).

EVENT L-5:

Objective: Observe TIS self alerts and target tracking during a common aircraft maneuver at the local airport. Verify TIS does not uplink self-alert messages.

Plan View



Aircraft	ID	Altitude (ft)	Speed (KIAS)	Sensor Location (lat/long)
Client (C)	TBD	TBD	140	Lat: 30 deg 26' 29.12302'' Lon: -74 deg 34' 57.88929''

During this event the Client(C) flew a series of low approaches to the ACY runway in a local traffic pattern. Aircraft flew three approaches and during each missed approach the aircraft came within 100' of the runway.